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BIRD TRENDS

A report on results of national ornithological surveys in Canada

Avian conservation is currently receiving much attention in North America. The status of seabird populations, including current estimates of numbers and indications of stability or change over time, forms crucial knowledge for conservation efforts. When combined with an understanding of the causes behind population change, population status is useful in identifying the species of greatest concern. Many of the articles in this issue of *Bird Trends* present new information of this kind, and describe both natural and man made threats. Although gaps remain, we now have a solid foundation for efficient and effective seabird conservation.

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Overview of seabird status and conservation in Canada

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Introduction

This article provides a summary of the status of seabird populations and their conservation across Canada. Each section represents a personal view or consensus amongst seabird biologists who are familiar with the current "state of the nation" for Canadian seabirds in each region. Although freshwater, the Great Lakes are included because gulls, terns and cormorants breed there as well as in marine areas.

Taken together these summaries provide several "take-home" messages. As we move into the next century (and millennium), Canadian seabird populations, with some exceptions, appear to be doing well. The same could not be said at the beginning of this century. Improvement in the lot of seabirds in Canada speaks to the success of the Migratory Birds Convention and Act, and ongoing conservation efforts by the Canadian Wildlife Service (CWS), provincial departments, universities and non-government organizations. Recent initiatives to collaborate with other circumpolar nations, with whom we share seabird populations, also has had a positive impact on seabird conservation here. However, there is a lot of work to do. Effective conservation of seabirds in Canada will require a strong, sustained commitment to support seabird programs by federal and provincial agencies in all regions. If this occurs, there will be further successes to report in the next seabird issue of *Bird Trends* five years from now.

Atlantic Canada

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Where information is available, populations of most species of seabirds in the Atlantic Region are stable or increasing. Notable examples include Common Murres (*Uria aalge*), Atlantic Puffins (*Fratercula arctica*), Razorbills (*Alca torda*), and Northern Gannets (*Morus bassanus*), which are doing well in their strongholds of Newfoundland and Labrador (Nettleship and Chapdelaine 1988, Rodway *et al.* 1996, Robertson *et al.* in prep.). The status of the most abundant breeding seabird in the region, the Leach's Storm-Petrel (*Oceanodroma leucorhoa*), is unknown at the core of its distribution in Newfoundland, however there is evidence

that colonies are declining at the periphery (i.e., Nova Scotia; A.R. Lock pers. comm.). Black-legged Kittiwakes (*Rissa tridactyla*) have suffered breeding failure in Newfoundland in recent years (Regehr and Montevecchi 1997), but numbers of breeders appear not to have been affected (Chardine unpubl.). Trends in terns (*Sterna* spp.) are difficult to establish because they are so mobile, but it seems that populations are declining in the Atlantic Region. The large tern colonies in Kouchibouguac National Park in New Brunswick and on Sable Island, Nova Scotia are presently stable (E. Tremblay, A.R. Lock pers. comm.).

Significant progress has been made on many seabird conservation issues in the region. Most major colonies are in protected areas under federal or provincial jurisdiction, but some require management plans (e.g., Funk Island, Newfoundland), and many require better enforcement of regulations. Tour boat traffic in Witless Bay, Newfoundland affected certain aspects of seabird behaviour but breeding success likely was unaffected (Hearne 1999). Likewise, visitation to Machias Seal Island by tourists appeared to have no effect on breeding terns there (Morrison 1996). Introduced predators such as rats (*Rattus* spp.) are not yet a problem in Atlantic colonies (they do occur on adjacent mainland areas), but naturally occurring arctic foxes (*Alopex lagopus*) can have huge impacts on seabird breeding activities (Birkhead and Nettleship 1995). Stocks of seabird forage fish such as capelin (*Mallotus villosus*) and herring (*Clupea harengus*) are currently increasing in Newfoundland and the Maritimes, and fisheries for both species are conservative (Anon 1998a, Anon 1998b). Availability of capelin to surface feeders such as kittiwakes in Newfoundland was likely reduced in the 1990s by colder water temperatures (Regehr and Montevecchi 1997). The murre harvest in Newfoundland has been cut in half to sustainable levels (see Chardine *et al.*, p. 11). Few seabirds are being caught in fishing gear because of the current groundfish moratorium in many areas of Atlantic Canada. However, unless the use of gill nets is restricted, this problem will return when fisheries are re-opened. Toxic chemical levels in Atlantic seabirds have declined since the 1970s, but are still relatively high in the Gulf of St. Lawrence (Noble and Burns 1990). Oil pollution stands out as a continuing major conservation concern for Atlantic Canada seabirds, and beached bird survey data suggest an increasing trend in rates of oiling (see Wiese and Ryan, p. 36). The recent discovery of a significant proportion of the North American Razorbill population overwintering around the Grand Manan area of the Bay of Fundy (Heuttmann *et al.* in prep.) underlines the vulnerability of seabird populations to localised threats such as oil spills.

Quebec North Shore and Gulf of St. Lawrence

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In general, seabird populations in the estuary and the Gulf of St. Lawrence, with a few exceptions, are currently increasing. Alcids such as Common Murres breeding in the sanctuaries of the North Shore have rebounded over the last 15 years, and are currently at their highest levels (20 000 pairs) since 1925, the year of the first survey in these protected areas (Chapdelaine 1995). Common Murres at Bonaventure Island also increased during the same period, and this remains the most important colony in the gulf with 27 000 pairs (Chapdelaine and Brousseau 1992). Other alcids, such as Razorbills and Atlantic Puffins, have increased over the last decade and new breeding sites have been recorded in the estuary and gulf (Chapdelaine and Rail 1996; Chapdelaine 1996a). The Northern Gannet colony at Bonaventure Island is currently growing at a rate of 3% per annum (Chapdelaine *et al.* 1987; Chapdelaine 1996b). If this pace is maintained, it should exceed 35 000 pairs by the year 2000.

In contrast, the numbers of Herring Gulls (*Larus argentatus*) have decreased in the sanctuaries on the North Shore (Chapdelaine and Rail 1998), Gaspé Peninsula (Chapdelaine and Brousseau 1992), and possibly in the estuary (Brousseau 1996a; J. Bédard pers. com). Kittiwakes also de-

creased during the last decade after their steady increase between 1974 and 1989 (Chapdelaine and Brousseau 1989; Brousseau 1996b), but this decrease does not apply to all colonies in the gulf. Common (*Sterna hirundo*) and Arctic Terns (*S. paradisaea*) are decreasing in some areas, possibly due to predation by large gulls (Guillemette 1993), and poor breeding success since 1990, the latter perhaps related to colder water temperatures at the beginning of the current decade.

At present, the major breeding colonies of seabirds in the estuary and the gulf benefit from legal protection through federal or provincial legislation. The large colony of Northern Gannets and Common Murres on Bonaventure Island lies within a provincial park and is protected as a Migratory Bird Sanctuary. On the North Shore, more than 90% of breeding alcids are located within federal sanctuaries established since 1925. The recent addition of the Gros Mecatina sanctuary, recognized as a major breeding site of Common Murre when John James Audubon visited the North Shore in 1833, completes the network of protected sites for seabirds. In the estuary, the most important colonies of species such as the Razorbill, Black Guillemot (*Cepphus grylle*), and Common Eider (*Somateria mollissima*) are located in national wildlife areas and islands acquired by the Société Duvetnor, a nonprofit organization devoted to the protection of key wildlife habitat.

Excellent progress has been made in providing legal protection to nesting seabirds and their breeding habitat in Quebec. However, much less progress has been made in protecting the nearby marine waters, which support the food chain essential to the well-being of local seabird populations. To fill this gap, CWS is looking to establish marine protected areas (MPAs) as National Wildlife Areas. The Department of Fisheries and Oceans (DFO) can also establish MPAs through the Oceans Act, and a collaborative management approach for the conservation and protection of marine ecosystems is underway to protect areas important to seabirds in Quebec. CWS-Quebec Region, has proposed four major areas in the Gulf of St. Lawrence that are intensively used by seabirds for breeding and feeding for consideration by DFO. The establishment of MPAs would allow for the control of human activities such as boat traffic, tourism, and fishing. It will be particularly important to manage fisheries that incidentally catch seabirds or deplete seabird food supplies in these areas.

Eastern Arctic

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Canada's Eastern Arctic, now mostly incorporated into the new territory of Nunavut, holds several outstanding seabird populations. It supports 10% or more of the world's Northern Fulmars (*Fulmarus glacialis*), Parasitic (*Stercorarius parasiticus*), Pomarine (*S. pomarinus*) and Long-tailed jaegers (*S. longicaudus*), Glaucous (*Larus hyperboreus*), Iceland (*L. glaucoides*), Ivory (*Pagophila eburnea*) and Sabine's Gulls (*Xema sabini*), Black-legged Kittiwakes, Arctic Terns, Thick-billed Murres (*Uria lomvia*) and Black Guillemots. Population trends are known for only a few of these species at a small number of sites. Information is best for the Thick-billed Murre (see Gaston, p. 7) where we can be fairly confident that numbers, although possibly lower than in the past, have been stable or increasing over the last two decades.

Apart from the Thick-billed Murre, our information is insufficient to speculate about regional population trends for any species, but there is some evidence that Arctic Terns have declined in Hudson Bay and perhaps Glaucous and Herring Gulls as well (see Gilchrist and Robertson, p. 28). Both Northern Fulmars and Black-legged Kittiwakes have been monitored at two colonies in the High Arctic (Prince Leopold Island and Coburg Island). Results from these monitoring efforts have not been analyzed, but preliminary impressions suggest little change in numbers since the mid-1970s.

There are no mechanisms to monitor several important arctic seabirds, especially Sabine's and Iceland Gulls and the noncolonial jaegers, of which 50% of the world population may breed here; this is cause for

concern. In addition, Black Guillemots, which constitute a distinct race in Canada and northwest Greenland (*Cepphus grylle ultimus*) and which breed in Jones Sound in their largest known colonies, are not being monitored at all. Most seabirds winter out at sea and are, therefore, even more difficult to monitor away from their breeding sites: these populations pose some of the greatest challenges in monitoring Canadian birds. A large proportion of some populations could be lost without anyone knowing.

Monitoring of toxic chemical loads in selected seabirds throughout the Arctic has been ongoing since 1975. Pollution of Arctic marine environments by airborne chemicals is well documented and is reflected in levels of organochlorines and other pollutants found in seabird eggs and tissues throughout the Eastern Arctic. Recent evidence suggests a substantial increase in mercury levels in Arctic seabird eggs since the 1970s. Apparently, none of these pollutants is at toxic levels: however their presence at all in otherwise untouched environments is disturbing.

Visits to seabird colonies by Arctic tour groups has increased dramatically this decade. Only one ship-based tour operated in the 1980s. In contrast, at least 8 groups will visit one or more arctic seabird colonies in the summer of 1999. Operational guidelines have been distributed to tour operators by the Canadian Wildlife Service in an attempt to minimize their disturbance to nesting birds. However, it is rarely possible to monitor their activities or their impact on nesting birds in the Arctic. Recently, two major seabird colonies have been assigned formal protected designation: Prince Leopold Island as a Migratory Bird Sanctuary in 1991, and Coburg Island as the Nirjutiqavvik National Wildlife Area in 1998. In both cases, a permit is required from the Canadian Wildlife Service to visit the colonies.

Few other human activities seriously affect seabirds in the arctic, but many species may be affected by changes in their wintering or passage areas.

Canadian Great Lakes

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There are two major concerns regarding colonial waterbirds in the Great Lakes. The first is the small and/or declining populations of Common Terns, Caspian Terns (*Sterna caspia*), and Herring Gulls. The second is the large and/or increasing populations of Double-crested Cormorants (*Phalacrocorax auritus*), Ring-billed Gulls (*Larus delawarensis*), and, to a lesser extent, Great Black-backed Gulls (*L. marinus*), which are affecting other colonial water birds, and creating conflicts with human interests.

Small and/or declining populations

A main stress on Common Tern populations is the invasion or takeover of colony sites by Ring-billed Gulls and/or vegetation. Only through the removal of Ring-billed Gull nests was the largest colony in Lake Erie maintained (Morris et *al*. 1992). Predation by avian and mammalian species, such as the Great Horned Owl (*Bubo virginianus*), Black-crowned Night-Heron (*Nycticorax nycticorax*) and mink (*Mustela vison*), also limit the success of colonies. Human destruction, degradation or disturbance of natural colony sites also affects Common Terns. Installation of nesting rafts in Toronto Harbour (Jarvie and Blokpoel 1996) and Frenchman's Bay in Pickering, and creation of wildlife islands in Hamilton Harbour (Pekarik et *al*. 1997) have been very successful in attracting this species.

For unknown reasons, Caspian Terns have recently abandoned some long-held colony sites in Lake Huron. Some Caspian Terns have become urbanised and, like Common Terns, can be managed by providing artificial nest platforms (Lampman et *al*. 1996) or islands (Pekarik et *al*. 1997).

Nesting populations of Herring Gulls in parts of Lake Superior have declined (Blokpoel and Tessier 1993) and food shortage is the suspected cause (L. Shutt et

al. unpubl. data). As phosphorus levels in most of the Great Lakes decline to meet clean-up targets, there is growing concern about reduced levels of nutrients and primary productivity in the water column. The impact this will have on the food web is still unknown.

Large and/or increasing populations

The large, and still increasing, Double-crested Cormorant population is an urgent management problem. A study by the New York Department of Environmental Conservation showed that these cormorants have a serious impact on smallmouth bass (*Micropterus dolomieui*) populations in eastern Lake Ontario (Schneider *et al.* 1998), where a cormorant population control program is proposed for 1999. Destruction of nest trees by nesting Double-crested Cormorants is a widespread problem on the Great Lakes. At Tommy Thompson Park along the Toronto waterfront, nesting cormorants have taken over nest trees of Black-crowned Night-Herons and they are now rapidly destroying those trees. On islands in western Lake Erie, there has been considerable destruction of the very limited Carolinian habitat.

There has been no lakes-wide census of the abundant Ring-billed Gull since 1989/91. This species is very adaptable and is likely still increasing its population wherever it can. At Ice Island in the upper St. Lawrence River, Ring-bills re-invaded a Common Tern colony after earlier management efforts had excluded gulls (Blokpoel *et al.* 1997).

Now nesting in all Canadian Great Lakes except Superior, Great Black-backed Gulls may soon become a problem in eastern Lake Ontario. The number of nests on the two colony islands there increased from 3 in 1985 to 25 in 1998. At one of these islands, Great Black-backs may already be affecting Caspian Tern numbers (D.V. Weseloh, unpubl.). Up-to-date census data are essential both for conservation and control activities. The third Canadian-American cooperative Great Lakes Colonial Waterbird Census is underway, with field work ending in the year 2000. Data from that census will help us in designing a conservation program.

Pacific and Yukon Region

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The Pacific and Yukon region of Canada supports large populations of breeding seabirds. Rodway (1991) estimated that over 5.6 million breed at more than 500 locations along the coast. Most important amongst the species are Cassin's Auklet (*Ptychoramphus aleuticus*), storm-petrels (*Oceanodroma furcata* and *O. leucorhoa*), Rhinoceros Auklet (*Cerorhinca monocerata*), and Ancient Murrelets (*Synthliboramphus antiquus*). Internationally significant populations of Cassin's Auklet, Ancient Murrelet and Rhinoceros Auklet breed in the Pacific region. Important seabird colonies are located off northern Vancouver Island, the Queen Charlotte Islands, and off the northern mainland coast. In addition, BC waters are important wintering areas for many Austral breeders, especially Sooty Shearwaters (*Puffinus griseus*).

Population trends for Pacific Region seabirds are not well known. A major effort to document the abundance and distribution of the region's seabirds by Kaiser, Rodway and co-workers (summarized in Rodway 1991) has not been repeated. Simon Fraser University and the Canadian Wildlife Service have started long-term seabird studies on Triangle Island, which is the largest seabird colony in British Columbia (see Bertram, p. 26). These studies have documented breeding failure in Tufted Puffin (*Fratercula cirrhata*), and declining breeding success in Cassin's Auklet. Timing of breeding is earlier now than in the 1970s. Trends appear to be related to reductions in nutrient levels in the upper layers of the Pacific. However, Ancient Murrelets, all of which breed in the Haida Gwaii archipelago, seem to be increasing where not affected by introduced predators (see Lemon and Gaston, p. 22).

Of the many potential conservation issues for seabirds, three continue to need attention in the Pacific Region: the effect on burrow-nesting auks of introduced mammalian predators in Haida Gwaii; mortality

of diving birds (auks, loons) from gill nets, mainly in the Straits of Georgia and around southern Vancouver Island; and the threat to Marbled Murrelets posed by the continued logging of their breeding habitat in old-growth forests. In addition, the possibility of a resumption of offshore oil exploration on the BC continental shelf creates a significant concern for seabirds. However, this threat is unlikely to materialise until the price of crude oil increases substantially.

The lack of population trend data makes it difficult to comment on the adequacy of conservation efforts for Pacific seabirds. However, an intensive campaign to eradicate rats (*Rattus norvegicus*) from Langara Island in 1995 was successful and there have been no signs of rodents since. A repeat census of the surviving Ancient Murrelet colony on the island will be carried out in 1999. Rats have also been eradicated from Cape St. James Island by the Gwaii Haanas Archipelago Management Board. In addition, a coordinated effort by the Canadian Wildlife Service, the BC Ministry of Environment, Lands and Forests, the Gwaii Haanas Archipelago Management Board, and the Laskeek Bay Conservation Society has resulted in a reduction in the damage caused by raccoons (*Procyon lotor*). Annual culling has resulted in the likely eradication of raccoons from Helgesen Island, formerly an important Rhinoceros Auklet colony. These efforts will continue with a view to preventing any further damage by raccoons to seabird populations. While it is known that alcids such as Common Murre, Rhinoceros Auklet and the endangered Marbled Murrelet (*Brachyramphus marmoratus*) are caught in salmon gill-nets in the Pacific region, the extent of the problem is unknown and needs to be assessed (K. Morgan pers. comm.).

Although the monitoring of seabird population trends in BC waters has been rather sparse hitherto, an excellent baseline of data on population sizes and distributions is available. Unfortunately, much of this information is now more than a decade old. Unless a vigorous attempt is made soon to develop a systematic monitoring program for the region, existing numbers will become mainly of academic interest. The lack of seabird monitoring in BC makes a strong contrast with what is going on in neighbouring Alaska, where annual monitoring of significant seabird colonies is a routine activity.

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Trends in Thick-billed Murre populations in the eastern Canadian Arctic

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Thick-billed Murres (*Uria lomvia*) breed in large numbers in the eastern Canadian Arctic, where they are the most abundant seabird in summer (Brown *et al.* 1975). Because they are the subject of a major harvest in their winter quarters off Newfoundland and Labrador (Elliot 1991), the Canadian Wildlife Service has invested considerable effort in censusing and monitoring them over the past 3 decades.

In addition to hunting, Thick-billed Murres suffer from other human activities, especially oil pollution, and drowning in gill nets (Evans and Nettleship 1985). Small numbers of eggs and adults are taken by native communities in Nunavut for subsistence purposes, but this harvest is regarded as insignificant compared to other factors affecting populations (Gaston *et al.* 1985).

Population censuses

Murres nest in very large colonies (50 000–500 000 + birds) on precipitous sea cliffs. Consequently, they are difficult to count and most colony censuses have been based on counts of birds from photographs taken either from the air or from boats. Such counts generally severely underestimate the number of birds present; birds at the edge of ledges obscure others behind them, while birds facing away from the camera, with their white underparts hidden, are hard to see, especially in areas of shadow. Conducting ground-truthing counts of selected areas simultaneous to the

photography can overcome these problems to some extent. However, ground truthing is not always possible and even land-based observers miss some birds. Moreover, because photo-counts are very labour-intensive (and hence costly), we cannot afford to do them often.

Because of the foregoing problems, only four of the eleven large aggregations of Thick-billed Murres in the eastern Canadian Arctic (Fig. 1) have had more than one complete census, and these (Huntzsch Island, Coats Island) are two of the smallest (Table 1). The results of the complete censuses suggested that numbers of Thick-billed Murres on Huntzsch Island remained stable through the 1970s, while those on Coats Island roughly doubled between 1972 and 1980 (Gaston *et al.* 1993). The Huntzsch Island colony is situated on a very small islet where birds nest densely on practically all cliffs. It is possible that this colony is limited by the availability of breeding sites and that no further expansion is possible. This does not appear to be true at any of the other colonies.

Indices of population change

Because complete censuses are difficult, time-consuming and expensive, the Canadian Wildlife Service tracks changes in Thick-billed Murre populations at most colonies by monitoring selected study areas through daily counts of the number of birds present at a fixed time. Study plots are chosen mainly for convenience of observation from the cliff top, but are selected to cover as much of the colony as possible and to include all types of breeding site (slope, aspect, ledge width, etc.). They are not a random sample of the colony and tend to be biased towards areas near the top of the cliff that are the easiest to see. Although this distribution is by no means ideal, it is the only practical arrangement given that, at many colonies, fog frequently prevents the counting of distant areas.

Figure 1. Distribution of Thick-billed Murre colonies in the eastern Canadian Arctic (see Table 1).

Table 1. Thick-billed Murre colonies in the eastern Canadian Arctic and the year, method and results of censuses (earlier "guestimates" giving orders of magnitude are omitted).

Colony	Year	Census type	Estimate(Breeding pairs)
1 Coburg Island	1980	Photographic	160 000
2 Prince Leopold I.	1976	Photo + ground	86 000
3 Cape Hay, Bylot I.	1976	Photo + ground estimate	140 000
4 Cape Graham Moore	1972	Photo	20 000
5 The Minarets*	1985	Ground estimate	133 000
6 Hantzsch Island	1973	Photo	50 000
	1982	Photo + ground	50 000
7 Akpatok I., North	1987	Photo	400 000
8 Akpatok I., South	1982	Photo	120 000
9 Digges Island*	1980	Photo + ground	180 000
10 Cape Wolstenholme*	1980	Photo	107 000
11 Coats Island	1972	Photo	95 000
	1990	Photo + ground	30 000

* Also known as "South of Red Bay"

* Digges Island and Cape Wolstenholme (10) on each are sometimes considered a single colony "Digges Sound"

Murres make no nest, incubating their single egg on the bare rock ledge, so it is not possible to distinguish breeding birds from non-breeders that may simply be squatting at an undefended site[2]. Consequently, all birds present in the area are counted. This number is always higher than the actual number of breeding sites, but is usually lower than the total numbers of breeding birds, as off-duty birds spend most of their time at sea. However, studies of changes in numbers of breeding sites and numbers of birds counted on study plots on Coats Island have shown that they are strongly correlated.

Monitoring of selected study plots has been carried out at three colonies. On Digges Island and Prince Leopold Island, baseline studies of breeding biology were carried out over a 3-year period, with daily counts of study plots made throughout each season. These intensive study years are used as a baseline against which subsequent monitoring visits are compared (mean count = 100). This eliminates the need for monitoring visits to be made consistently on the same date each year, as counts for a given year can be compared with the corresponding dates for the baseline years. Due to ongoing banding studies on Coats Island, visits have been made annually since 1985. Counts have been made every year between 1–7 August as this period encompasses the middle of chick-rearing when numbers of adults tend to be at their most stable (Gaston and Nettleship 1981).

On Prince Leopold Island, study plot counts have shown a consistent increase of about 1.7% annually since the baseline years of 1975–1977 (fig. 2). There is no evidence

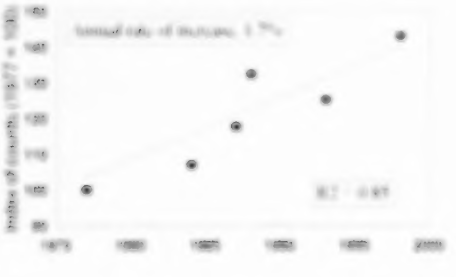

Figure 2. Recent trends for study plots monitored on Prince Leopold Island.

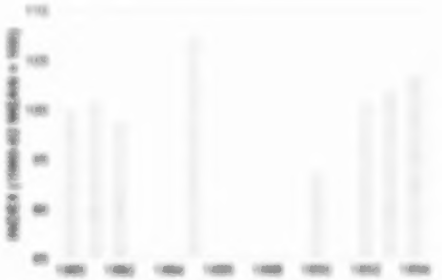

Figure 3. Recent trends for study plots monitored on Digges Island.

of a significant change in numbers on Digges Island from the baseline studies in 1980-82 to 1994 (Fig. 3). For Coats Island, where information is more detailed, the increase detected from the whole-colony counts reversed abruptly during 1990-1991, but resumed in 1992, possibly becoming more rapid from 1996 onwards (Fig. 4).

Most of the increase on Coats Island has occurred through colonization of higher parts of the cliffs, so that the colony is expanding upwards. When the 10 study plots are divided into those in the middle of the colony and those on the upper edge, it is clear that almost all of the increase has occurred at the marginal plots (Fig. 5). As areas at the margin of the colony constitute much less than half the total population of the colony, the average rate of increase of the whole colony must be substantially lower than the rate of increase of the study plots. Comparisons of earlier and recent photographs show the area of the colony has expanded, so an increase in the population has certainly occurred.

Discussion: future needs

Our current monitoring plots constitute tiny samples of the colonies involved (on Digges Island, ~1% of the total population) and we cover only 3 colonies, comprising less than one quarter of the Eastern Arctic population. This is clearly not adequate. The results of banding studies suggest that each colony has its own distinctive wintering behaviour, so that the proportion of birds of different age classes that are shot off Newfoundland varies greatly, and unpredictably, among colonies. In view of this, the effects of hunting are expected to vary widely among colonies. Although it is clearly impracticable to monitor all colonies regularly, population trends for at least half of our colonies, especially the largest (Coburg Island, Cape Hay and Akpatok Island North) should be determined.

The photo census on Coburg Island was repeated in 1998, the results of which should provide some idea of the trends there. Unfortunately, the original censuses for Cape Hay and Akpatok North were based on sampling techniques, which are less accurate than counts at other colonies. Consequently, only changes at these colonies that are very large may be detectable. Despite this, study plots have been selected and baseline counts are available, and return visits of 2–3 weeks at both colonies are highly desirable before we reach the millennium.

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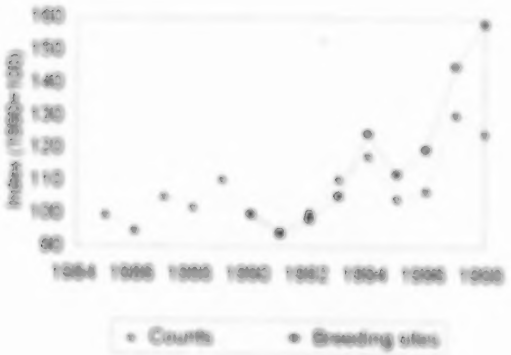

Figure 4. Recent trends in counts of birds and breeding sites on Coats Island

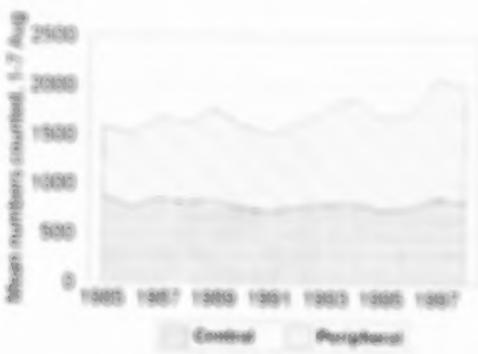

Figure 5. Trends in counts on Coats Island for central and peripheral study plots.

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Trends in the annual harvest of murres in Newfoundland and Labrador

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Introduction

Murres (*Uria* spp.) have been hunted for food in outports of coastal Newfoundland and Labrador (referred to as "Newfoundland" hereafter) for centuries. However, when Newfoundland joined Canada in 1949, it became illegal for non-native people to hunt murres due to their classification as "non-game birds" under the Migratory Birds Convention Act (MBCA). The continuation of the traditional Newfoundland murre, or "turr", hunt was allowed through a special regulation added to the MBCA in 1956. The current regulation specifies that residents of Newfoundland can hunt murres without a permit only for human food, between 1 September and 31 March. Unfortunately, the regulation does not provide a mechanism to manage the harvest through bag limits, adjustments to the hunting season, or other means. With no required murre-hunting permit, the task of estimating the harvest is very difficult. Furthermore, MBCA regulations enabling the management of migratory game bird harvests do not apply to non-game birds, including murres.

Surveys and field studies beginning in the late 1970s (Wendt and Cooch 1984, Elliot 1991, Elliot *et al.* 1991) estimate the annual kill of murres to be in the order of 600 000 to 900 000 birds. Thick-billed Murres (*U. lomvia*) made up the majority (95%), and Common Murres (*U. aalge*) the remainder. Birds were taken primarily from the Northern Peninsula, northeast coast, Avalon Peninsula and south coasts of insular Newfoundland from October to March. About 50% of the harvest comprised first-year birds, but the proportion of adults killed increased through the season.

Background to 1993 hunting restrictions

The large size of the murre harvest raised concern among biologists, managers, and hunters, so the Canadian Wildlife Service (CWS) embarked on an information campaign and research project in the late fall of 1983. The purposes were: (1) to inform hunters of the biology of murres, and impacts of the harvest and other mortality on murre populations; 2) to emphasise the need to conserve populations by reducing the number of birds killed; and (3) to add to our knowledge of the biology of the hunt (Elliot 1991). Simple population models developed by CWS (Gaston and Elliot unpubl., Chardine 1988) indicated that the current harvest was unsustainable and would have to be reduced by 30% to maintain a stable population. An opportunity to manage the murre harvest came late in 1992. CWS was advised that the murre hunt was subject to the MBCA regulation allowing the Minister of the Environment to vary quotas or hunting seasons for migratory birds to respond to a conservation concern.

With this legal mechanism to manage the murre hunt, CWS developed a murre harvest management plan using information collected from hunters in 17 communities (Elliot *et al.* 1991), and from results of the 1989 Newfoundland Hunter Opinion Survey (Chardine 1994). Computer simulations (Chardine unpubl.) were used to develop a combination of bag limits and shorter hunting seasons that were acceptable to hunters and would result in a harvest reduction of 30% in three (later four) murre hunting

zones. Throughout this process, murre hunters were consulted extensively, and individual hunters, the general population and a working group (Murre Advisory Group) of volunteers interested in sustaining the hunt were very supportive. Restrictions were first put in place in 1993-94 and are expected to continue until a more robust mechanism for regulating the murre hunt is established. A protocol to amend the Migratory Birds Convention between Canada and the US, and acknowledge the special case of the Newfoundland murre hunt (among other issues) is currently awaiting approval in the US. Once amended, management of the hunt will be more straightforward, and will allow for the requirement of a murre-hunting permit.

Current hunting restrictions and trends in annual murre harvest

Figure 6 shows the four murre hunting zones currently in place. Each zone has a different hunting season lasting about 85 days (excluding Sundays), with no hunting season open past 10 March (similar to migratory game bird seasons). The bag limit is 20 murres per hunter per day in all zones. Hunters are allowed to possess a maximum of 40 murres at any time.

The annual murre harvest has been estimated 12 times since the 1977-78 hunting season, using a special survey mailed to migratory game bird hunting permit holders (see Elliot *et al.* 1991 for methods). Murre hunters not purchasing a permit were sampled from the Newfoundland provincial big game licence file in 1990-1991. Harvest trends for the period 1977 to 1998 are presented only for murre hunters with permits, as they are the only group consistently surveyed. The total har-

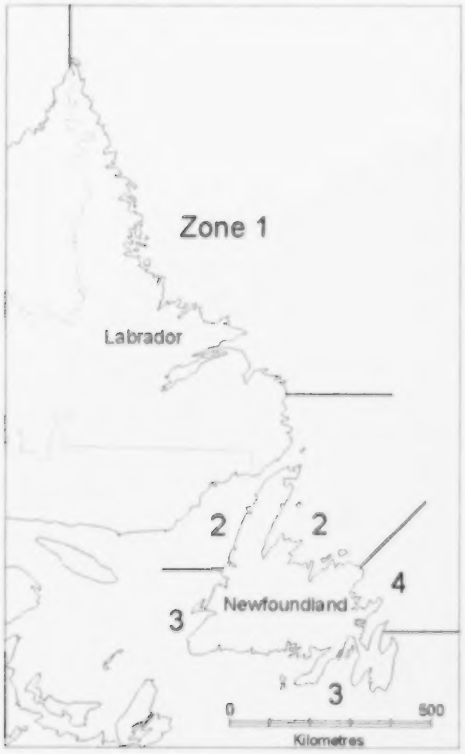

Figure 6. Map showing boundaries of murre hunting zones currently in place. Hunting seasons (for 1997-98) are as follows: Zone 1: 5 September to 12 December; Zone 2: 10 October to 16 January; Zone 3: 28 November to 10 March; Zone 4: 7 November to 9 January, and 30 January to 10 March.

vest by all murre hunters is about double the harvest for permit holders (Elliot *et al.* 1991).

Figure 7 shows the annual murre harvest estimates for permit holders from the 12 surveys. Harvest estimates vary considerably among years. The estimated kill was particularly high in 1982-83 when hunters reported good hunting conditions and plentiful birds. Elliot *et al.* (1991) estimate about 1.5 million murres were killed that season. Overall, murre harvest has declined since the late 1970s, with the lowest estimates from the last three surveys which followed the imposition of hunting restrictions. Excluding the very high estimate for 1982-83, the average harvest estimate prior to hunting restrictions was about 400 000 birds, compared to 134 000 birds after restrictions. This suggests that the annual harvest has been reduced by 66%, exceeding the target of 50%. Accounting for murre hunters who do not purchase a hunting permit, the total annual harvest of murres is currently about 250 000 to 300 000 birds. This level of harvest probably can be sustained by the population.

Many factors, such as weather, ice conditions and availability of birds, influence the size of the annual murre harvest. However, the consistently lower harvest estimates from the three independent surveys after hunting restrictions were imposed strongly suggests that these restrictions resulted in reduced harvests. Hunters reported that weather and availability of birds were poor in 1995-96 and somewhat better in the next season (see also Collins and Lévesque 1997a), which may have reduced the harvest further. Hunting conditions improved in the 1997-98 season, when the last harvest survey was conducted, however, the estimated kill was still relatively low and within the range reported for 1995-96 and 1996-97 seasons. (Collins and Lévesque 1997b).

Hunter compliance with the bag limit of 20 murres per day appears to be high (W. Turpin pers. comm.). There is no doubt that the bag limit has reduced substantially the number of large kills of birds (up to 200–300 per boat, R.D. Elliot and P.C. Ryan pers. obs.) that occasionally occurred when weather conditions were good and many birds were in easy reach of hunters. The 10 March closing date for the hunt contributes by reducing these fair-weather opportunities. The average number of murres taken by a hunter in a single day also has declined since the imposition of a bag limit, and the shorter seasons have reduced the average number of days people hunt for murres (Elliot *et al.* 1991, Collins and Lévesque 1997a and b). The closure of the hunt after 10 March has been

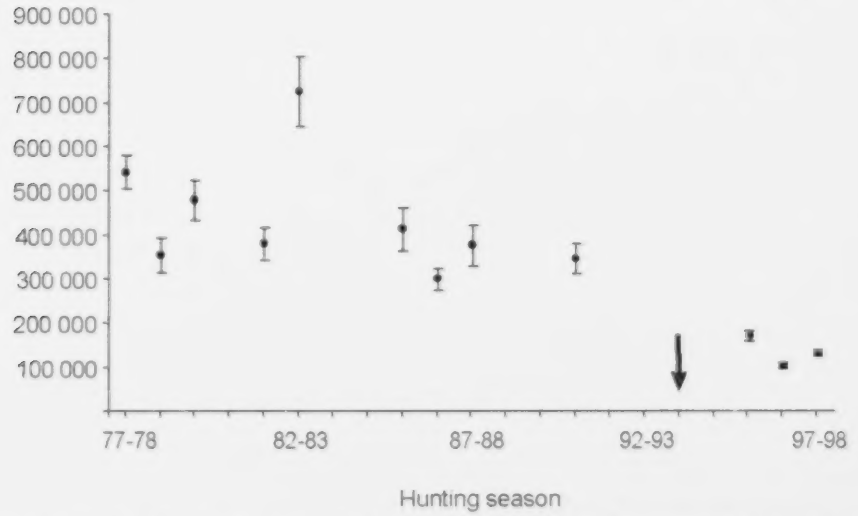

Figure 7. Estimated number of murres harvested by Migratory Game Bird Permit holders (± 1 SE). Hunting restrictions were imposed in the 1993-94 season.

particularly effective in reducing the harvest by eliminating large kills observed at this time of year as a result of improving weather and abundant birds, some of which would be returning to breeding colonies. Further, there is evidence that illegal selling of murres has decreased with the declining availability of excess birds (W. Turpin pers. comm.).

It is important to note that these harvest estimates, particularly those obtained after the imposition of hunting restrictions, may be biased low: hunters are unlikely to report illegal kills over the bag limit or out of season. Also, an unknown proportion of murres are fatally wounded during the hunt but are not retrieved by hunters. These birds are not included in harvest estimates.

Although the reduction in annual harvest following hunting restrictions in 1993 is obvious, harvest was on the decline prior to this (Fig. 7). Since the late 1970s, when murre harvest surveys began, migratory game bird hunting permit sales in Newfoundland have decreased by half (from about 35 000 to 15 000 permits), and the number of permit-holding murre hunters has decreased by about the same proportion (Elliot *et al.* 1991, Collins and Lévesque 1997a and b). Although this trend could be caused by a decreased proportion of murre hunters buying permits, it probably reflects a real reduction in the number of murre hunters. It is clear that fewer Newfoundlanders are hunting migratory game birds now than in the past, and this likely applies to murres as well.

If more murres now survive each hunting season, population growth at the breeding colonies would be expected. As murres start breeding at 4 or 5 years of age (Gaston *et al.* 1994), increases in the numbers of pre-breeders at the colonies were not expected until 1997-98, 4 to 5 years after current hunting restrictions were imposed. It is encouraging to report observed increases in the number of Thick-billed Murre recruits to the colony at Coats Island, Northwest Territories starting in 1997 (A.J. Gaston pers. comm.). Although a relatively small colony, banding studies have shown that Coats Island is an important source of murres harvested in Newfoundland. Continued monitoring at that site is needed to confirm this trend.

Regular tracking of the annual murre harvest and accurate estimates of the total harvest will continue to be important in the future. This will be easier once a murre-hunting permit is mandatory. Continued monitoring of Arctic colonies of Thick-billed Murres is needed to ensure that populations are not adversely affected by the Newfoundland harvest. It is important to maintain effective communication with murre hunters so that they continue to play a role as partners in murre conservation. Ultimately, a flexible system for managing the Newfoundland murre harvest will contribute to sustained northwest Atlantic murre populations, and a continuation of the traditional Newfoundland "turr" hunt into the foreseeable future.

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Population status and trends of the Atlantic Puffin in North America

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Introduction

The best known of all Canadian seabirds, the Atlantic Puffin (*Fratercula arctica*) attracts many thousands of tourists every year to colonies in Newfoundland, the Gulf of St. Lawrence, the Bay of Fundy, and Maine, and is featured widely in company logos and advertising campaigns. The Atlantic Puffin ("puffin") is a relatively common seabird world-wide: an estimated 5.7–6.0 million pairs breed at colonies on often remote islands or mainland sites in northwest Russia, Norway, Iceland, the Faeroe Islands, the UK, Ireland, northwest France, Greenland and eastern North America (Nettleship and Evans 1985, Lloyd *et al.* 1991). The total world population of puffins, including birds that have not started to breed (less than 5 years old; Hudson 1985) is almost double the number of breeders, or about 20 million birds (Chardine, unpubl.). These figures should be taken as approximate because puffins are difficult to count, some colony estimates are old, and the very large Iceland population (2–3 million pairs at 600–700 colonies, Petersen pers. comm.) is in the process of being enumerated.

Current status of puffins in North America

About 375 000 pairs breed at 80 colonies from the high Arctic to Maine (Table 2). Puffins are not evenly distributed throughout their North American range. Over 90% breed at eight main colonies in eastern Newfoundland and southern Labrador. The most important breeding area for puffins in North America is Witless Bay, in southeast Newfoundland, where about 57% of all North American birds breed on three islands within 8 km of each other (see Rodway *et al.* 1996). The North American puffin population, predominantly the *F. a. arctica* subspecies, represents only about 10% of the world puffin population.

Population trends in North America

Centuries ago, puffins were almost certainly more common than at present (Nettleship and Evans 1985). Although historical trends are difficult to establish, it appears that puffin populations in North America reached a recent low in the early 1900s. Since then, hunting, egging and habitat loss have eased, and it now appears that North American puffin populations are on the increase.

The number of puffin colonies is increasing in North America. New, small colonies have appeared recently in Quebec (G. Chapdelaine pers. comm) and Nova Scotia (A.R. Lock pers. comm). A program to translocate chicks from Newfoundland to Maine (Kress and Nettleship 1988) has re-established several colonies there. About 55

Table 2. Number of Atlantic Puffin colonies and breeding pairs in various regions of eastern North America.

Region	Number of colonies	Number of Breeding pairs
Eastern Arctic	4	200[1]
Labrador	22	87 506[2]
Eastern Newfoundland (insular)	26	270 320[3,4]
Gulf of St. Lawrence	19	17 935[5]
Scotian Shelf/Bay of Fundy/Gulf of Maine	9	1 148[3]
Totals	80	377 109

Sources:

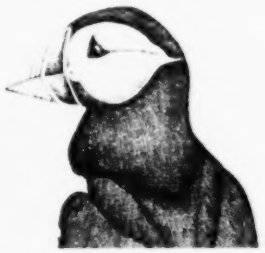
1. Nettleship and Evans 1985
2. Nettleship and Glen unpubl.
3. Lock et al. 1994
4. Rodway et al. 1996
5. G. Chapdelaine pers. comm.

puffin colonies were known in North America in 1985 (Nettleship and Evans 1985); now we think there are about 80 (Lock *et al.* 1994). Some of this increase is likely related to improved knowledge of colony locations or to differences in defining what constitutes a colony. However, taken together these observations suggest that puffins now breed at more locations than in the recent past.

Trends in numbers of puffins breeding at North American colonies are known for some locations. Puffins have increased along the coast of Labrador since the 1950s (Nettleship and Evans 1985) but recent trends are unknown. A reassessment of the large colonies on the Gannet Islands in Labrador is planned for 1999 and will allow comparisons with estimates from the 1980s. Excellent trend data exist for some puffin colonies along the North Shore of the Gulf of St. Lawrence (Chapdelaine 1995). The number of puffins breeding at four migratory bird sanctuaries there increased from about 30 000 pairs in 1925 to over 40 000 in the mid-1930s, then declined significantly to about 7500 in the mid-1970s (Chapdelaine pers. comm.). The decline was caused by excessive hunting, egging and disturbance at the colonies by local inhabitants, and involved other seabirds as well as puffins (Blanchard 1994). An information and education program coupled with enhanced enforcement of migratory bird laws appear to have reversed the decline. Puffins have since increased to over 20 000 pairs but have not yet reached levels seen in the 1930s. The number of puffins breeding at Machias Seal Island in the Bay of Fundy has increased from about 50 pairs in the late 1800s to probably about 3500 pairs now (A. W. Diamond pers. comm.). The small puffin colonies on the coast of Maine are now increasing as a result of intensive restoration efforts by Steve Kress and the National Audubon Society (Kress and Borzik 1998).

Trends in North American puffins are determined to a significant degree by the situation at their stronghold in the Witless Bay Seabird Ecological Reserve in southeast Newfoundland. Unfortunately, despite the importance of these colonies, there are few published estimates for puffins nesting in the reserve. The latest comes from 1993-94 for Great Island, the largest of the three colonies, and stands at 123 000 (±7000) pairs (Rodway *et al.* 1996). These authors made a careful comparison between their estimate and one from 1979 (Cairns and Verspoor unpubl.), and showed that puffins increased in numbers on Great Island in the intervening period. The increase was evidenced by an 18% expansion of the colony area (Rodway *et al.* 1996).

Monitoring and conserving North American Atlantic Puffins



Effective conservation requires up-to-date information on populations and their threats. For puffins, accurate indices of population change at the main colonies, in particular Witless Bay, are needed. An excellent model is the survey carried out every five years at migratory bird sanctuaries along the North Shore of the Gulf of St. Lawrence (Chapdelaine 1995). Monitoring is also needed at the periphery of the puffin's range where population expansion or retraction would likely be detected first. In addition to assessing population size, monitoring of breeding success and adult survival is required regularly so that changes that may be cause for concern can be detected, and any population changes that may be observed can be explained. Breeding success has been measured at some colonies, but, as yet, there are no estimates of adult survival for North American puffins. Studies currently underway at Machias Seal Island, Gull Island (Witless Bay), and the Gannet Islands (Labrador) will produce adult survival estimates in the near future (A.W. Diamond, I.L. Jones pers. comm.). It is also important to periodically monitor the food puffins feed their chicks so that changes in food types or availability can be tracked.

Although the pressure placed on puffin populations in the late 1800s and early 1900s in the form of hunting, egging and disturbance has decreased, efforts to conserve puffins, and all Canadian seabirds, must remain assiduous. Most major puffin

colonies in North America are protected in federal or provincial reserves. However, effective protection in a reserve setting requires adequate enforcement of regulations, and a general public that is informed of the sensitivity of colonies to human visitation. Important puffin colonies must stay free of introduced predators such as rats, which are common on the mainland adjacent to many North American puffin colonies. Bans on puffin hunting implemented in Canada in 1917 and Newfoundland in 1949, need continued effective enforcement. Gill-net fisheries that have resulted in the drowning of many puffins in the past are currently closed. If these fisheries are re-opened, the use of gill-nets near colonies must be restricted. There is no evidence that North American puffins are suffering from food shortage. However, fisheries for species that puffins and other seabirds consume need to be managed conservatively so that adequate food supplies are maintained. Oil pollution, which is known to kill seabirds, needs to be reduced or eliminated in waters frequented by puffins.

Conclusion

Overall, it appears that Atlantic Puffins are recovering from past population declines in North America. Numbers may never reach the historical maximum, whatever that might have been. However, this should not necessarily be viewed as discouraging. Throughout the long evolutionary history of puffins, it is reasonable to suppose that populations have waxed and waned extensively in relation to factors such as global climate change. Past populations likely have been both lower and higher than at present. Thus we lack an historical benchmark to use as a target for current conservation efforts. Conservators of contemporary puffin populations need to be concerned with maintaining and enhancing current population levels, and minimising human impacts. Although past population highs may never be attained, we should take the recent population increases as an indication of the success of conservation efforts in North America over the past few decades.

Acknowledgements

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North American Colonial Waterbird Conservation Plan

North American Colonial Waterbird Conservation Plan

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Canada is participating in the development of the North American Colonial Waterbird Conservation Plan (NACWCP), launched in July 1998 by the US Fish and Wildlife Service. The mission of the initiative is "to create a cohesive, multi-national, partnership for conserving and managing colonial-nesting waterbirds (seabirds, wading birds, terns and gulls) and their habitats throughout North America." CWS is a partner with non-government agencies, researchers, private individuals, academics, and federal and state government agencies who will develop the NACWCP over the next two years in concert with other bird conservation planning efforts presently underway.

Population status and current trends of Razorbills in Canada

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Distribution of breeding Razorbills

Of the colonial auks currently monitored in the North Atlantic, Razorbills (*Alca torda*) appear to be the least abundant species. Razorbill colonies in Iceland are the largest in the world, supporting more than 450 000 pairs; however, this is a relatively small population compared to 1 295 000 pairs of Common Murre (*Uria aalge*), 756 000 pairs of Thick-billed Murre (*U. lomvia*) and 3 to 4 million pairs of Atlantic Puffin (*Fratercula arctica*) (Lilliendahl and Solmundsson 1997, Gaston and Jones 1998). In the British Isles there are about 147 000 Razorbills; again, a much smaller number than the 1 million Common Murres and more than half million Atlantic Puffins (Lloyd *et al.* 1991). Norwegian colonies harbour 30 000 pairs of Razorbill, 110 000 pairs of Common Murre and 1 300 000 pairs of Atlantic Puffin (Lloyd *et al.* 1991).

In Canada, Razorbills are also much rarer than other alcids breeding in northwestern Atlantic colonies. Recent reviews (Nettleship and Evans 1985, Lock *et al.* 1994) tentatively estimate the Razorbill population at 15 000–20 000 pairs, compared with 600 000 pairs of Common Murre and 365 000 pairs of Atlantic Puffin. Thick-billed Murre numbers are estimated at only 13 000 pairs in southern Canadian waters, but more than one and a half million pairs breed in the Canadian Arctic. The bulk of the Razorbill population in the northwest Atlantic is centered in southern Labrador on the Gannet Islands. The second most important concentration is on the St. Mary's Islands and the nearby Boat Islands, along the North Shore of the Gulf of St. Lawrence (Fig. 8). The small total North American population and the large decreases which occurred in the Gulf of St. Lawrence between 1970 and 1983 (Chapdelaine and Laporte 1982) led to more detailed studies of Razorbills in Canadian waters.

Trends in Québec

Our knowledge of the status of seabirds in Canada is gained from a variety of monitoring programs conducted by CWS biologists, other researchers, volunteer-based surveys by NGOs and graduate students from universities. The

Figure 8. Distribution of Razorbill colonies in North America.

oldest information source for monitoring Razorbill populations is the five-year census of Migratory Bird Sanctuaries on the North Shore of the Gulf of St. Lawrence, undertaken since 1925. These surveys showed a general decline in Razorbill populations in the sanctuaries between 1960 and 1982, with particularly severe declines in large colonies (Fig. 9). Numbers of Razorbills in the Wolf Bay sanctuary peaked at 11 000 individuals in 1965 and fell steadily to only 242 individuals in 1988. On the St. Mary's Islands, currently the most important breeding site on the North Shore of the Gulf of St. Lawrence, the population was estimated at 5450 individuals in 1960, but diminished to 1192 by 1977 (Fig. 9).

Subsequent surveys of the sanctuaries in 1988 and 1993 were more encouraging, showing a general increase of 4% per year (Chapdelaine 1995). Surveys at Corossol and Betchouane sanctuaries in 1998 indicate this increase is continuing (Fig. 9). Elsewhere in the gulf, surveys are sparse, but the two small Razorbill populations (600 individuals) of Bonaventure Island and Forillon Peninsula showed a similar increase (Chapdelaine and Brousseau 1993). In the estuary, over 2000 Razorbills nest on Les Pèlerins and Brandypot Islands off Rivière-du-Loup. Historical data is insufficient to assess any trends in this population, but opportunistic counts suggest an increase during the last ten years (J. Bédard, pers. comm.). The total population of Razorbills in the estuary and Gulf of St. Lawrence is about 16 500 individuals, distributed among 70 colonies.

Trends in Labrador and Newfoundland

The largest Razorbill breeding colony in North America is on the Gannet Islands, in Groswater Bay off the southeastern coast of Labrador. The Gannet Islands include Outer Gannet to the north, and the Gannet Clusters, a group of six islands. The four smallest islands in the cluster harbour large colonies of Common Murres, Atlantic Puffins, and Razorbills. These islands are protected as Ecological Reserves by the government of Newfoundland and Labrador. In 1978, the Razorbill colony was estimated at 6747 pairs (2657–10 837, 95% CI) (Elliot and Lock, unpubl. data), and 6290 (4132– 8448) pairs in 1983 (Elliot and Nettleship, unpubl. data). In 1998 the estimate was 10 497 (7806–13 188) pairs (Robertson and Elliot, unpubl. data), significantly different from the 1983 estimate ($P=0.013$). Another survey is planned for 1999 to ensure that the current estimate of about 10 000 pairs for this important colony is reliable.

Total numbers of Razorbills breeding on numerous smaller colonies along the Labrador coast (from Groswater Bay to Nain) are probably similar to the size of the Gannet Island colony. The largest concentrations are at the Herring Islands (1600 pairs in 1978) and the Bird Islands (1250 pairs in 1978) in Groswater Bay (Elliot and Lock, unpubl. data). Most of these colonies have not been surveyed since the late 1970s, so there is no information on population trends.

While Newfoundland is blessed with huge numbers of seabirds, Razorbills are few in number. The largest colony is on Funk Island with 200 pairs nesting among crevices (Montevecchi and Tuck 1987). There is no information on trends.

Trends in the Maritime Provinces

The breeding population on Machias Seal Island, at the mouth of the Bay of Fundy, appears to be increasing. The numbers of occupied nest sites, most of which are under inaccessible boulders, are not known, but the maximum numbers of individuals counted from the top of the lighthouse during the breeding season rose from 211 in 1994, to 300–325 in 1995-1997, to 632 in 1998 (J. Hudson, pers. comm.). Applying the lowest *k*-ratio (see Survey techniques, below) from the Gulf of St. Lawrence colonies ($k = 1.12$) suggests that numbers of breeding pairs have risen from about 230 in 1994 to around 700 pairs in 1998. Additionally, adults were seen in 1998 regularly attending sites in areas where they had not nested in the previous three years (Diamond, unpubl. data).

The colony on Yellow Murre Ledges (south of Grand Manan) was occupied by about 150 Razorbills (and 150 Common Murres) when last visited in July 1997 (K. Mawhinney and J. Drury, pers. comm), similar to counts

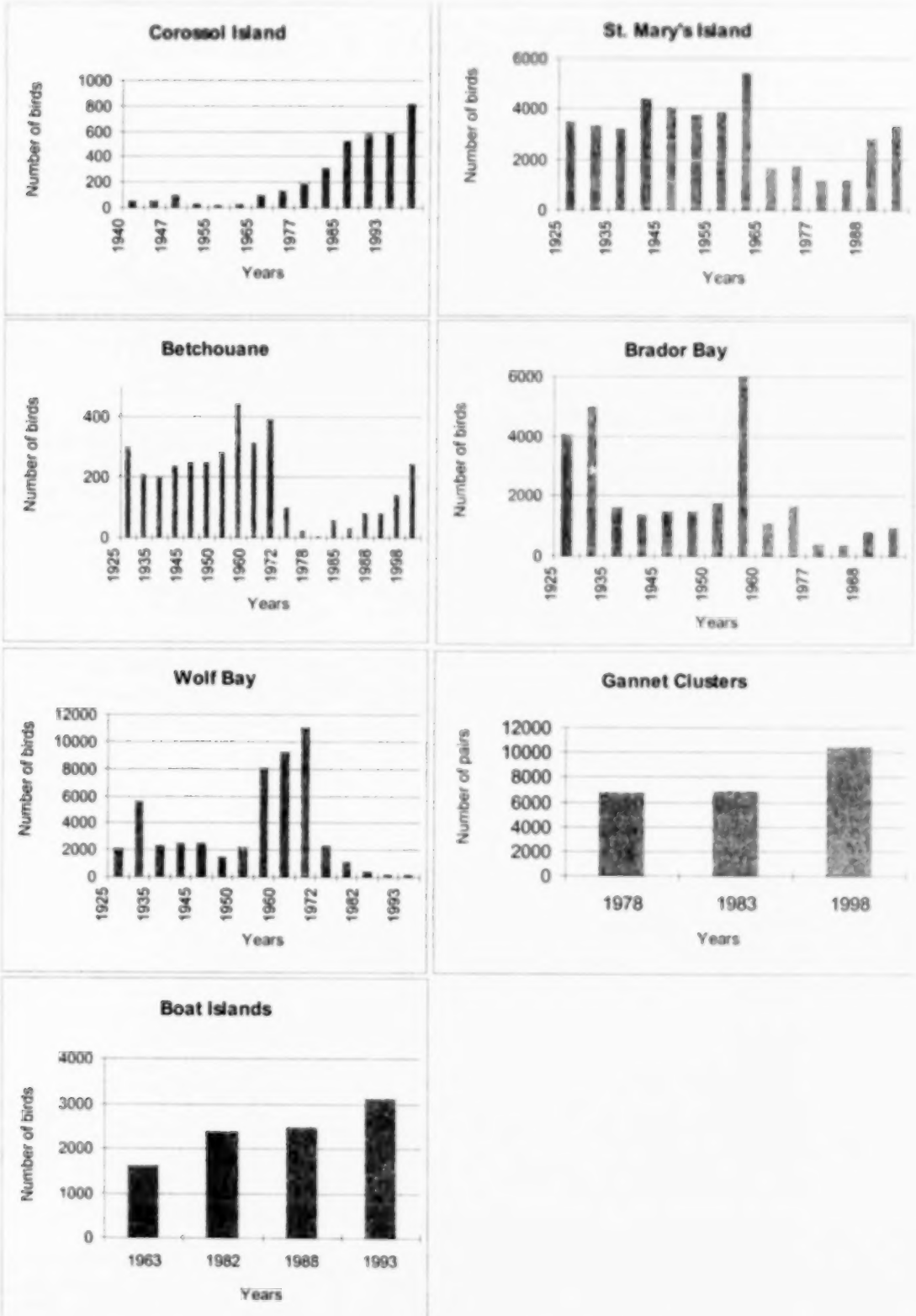

Figure 9. Population variations of Razorbill in the most important North American colonies.

of 150 in 1924 and 200 in 1935 (Squires 1976). In the Bay of Fundy, a handful of pairs colonized South Wolf Island, New Brunswick in the mid-1990s (Mawhinney and Sears 1996). About 100 pairs bred at two sites on the coast of Cape Breton, and at Pearl Island, Nova Scotia (Erskine 1992). There is no information on population trends in Nova Scotia.

Survey techniques

There are potential problems with the techniques used to estimate the number of breeding Razorbills. Ideally, direct nest counts should be made, but counts of birds at or near colonies continue to be used because of restrictions on time, the likelihood of disturbance, or because nests are hidden or inaccessible. The traditional surveys of the North Shore colonies are a mixture of systematic counts of eggs or nests, and birds observed nearby. Also, at specific study plots, numbers of eggs or chicks (N_p) and number of adults (N_t) counted are used to derive a correction factor ($k = N_p/N_t$). This *k*-ratio is used to estimate the number of pairs in the colonies when only the number of attending adults can be counted. Correction factors are often different between colonies, due to daily and seasonal variation in attendance patterns and nesting habitat differences. On the St. Mary's Islands, Cairns (1979) reported a *k*-ratio of 1.53 and calculated error in population estimates at 186% after a single count and 59% after ten counts. In the Wolf Bay sanctuary, Chapdelaine (1978) calculated *k*-ratios ranging from 1.12 to 4.00 in colonies where egg counts were not feasible. In contrast, *k*-ratios calculated at British Razorbill colonies range from 0.59 to 0.77 (Lloyd *et al.* 1991) with estimated error as low as 17% for single counts (Lloyd 1975). In Britain, many birds nest on ledges which are visible; this situation rarely occurs on the North Shore where Razorbills nest in deep rock crevices or in boulder scree. For the Gannet Island surveys an attempt was made to reduce biases caused by daily changes in *k* by obtaining island-specific *k*-ratios (ranging from 0.82 to 9.00) at the same time as the survey.

Future directions

Efforts should focus on regular and continued monitoring of key Razorbill breeding colonies in Labrador, the estuary and Gulf of St. Lawrence, and the Bay of Fundy. Whether *k*-ratio techniques produce unbiased estimates of the true number of breeding pairs needs to be assessed. Long-term research to estimate and monitor demographic parameters such as productivity and survival rates (via banding programs) are needed. Radio and satellite transmitter marking programs would be very useful in identifying population units on the wintering grounds. These studies would obtain crucial information needed to effectively address Razorbill management and conservation concerns.

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Trends in Ancient Murrelet populations since 1980

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Many of the small forested islands of the Haida Gwaii (Queen Charlotte Islands) archipelago in British Columbia support nesting colonies of the Ancient Murrelet (*Synthliboramphus antiquus*). Deep within the moss carpeted Sitka Spruce and Western Hemlock forests of these islands, this small alcid constructs burrows under fallen logs, tree roots and stumps. At the end of the tunnel, in a shallow nest cup loosely lined with leaves and twigs, it lays 2 eggs. The chicks, once hatched, are completely precocial, leaving the burrow at two days of age and making their way over downed trees and cliffs to the rocky shores where they swim out to reunite with their parents on the ocean.

Approximately half a million Ancient Murrelets nest on 31 islands in Haida Gwaii. The 17 colonies along the east coast of Moresby Island, mostly within Gwaii Haanas National Park Reserve, support an estimated 44% of the breeding population, while the 4 colonies on the west coast of Graham Island house nearly half (49%). The remaining 7% nest in 10 colonies on the remote and rugged west coast of Moresby Island (Rodway 1991). British Columbia, the only location where they breed in Canada, supports about half of the currently known world breeding population. Predation by rats (*Rattus* spp.) and raccoons (*Procyon lotor*), both introduced to Haida Gwaii since the arrival of Europeans, threaten the breeding colonies of many seabirds on the islands. In Canada, the Ancient Murrelet is designated by COSEWIC as vulnerable due to recent population declines (Gaston 1994). These seem to be almost entirely due to introduced predators.

Seabird colony surveys conducted along the BC coast during the mid-1970s by the BC Provincial Museum identified colony sites and provided rough estimates of breeding birds, which can be used to detect only very large changes in nesting distribution and population size. Between 1980 and 1986, the Canadian Wildlife Service conducted an inventory of nesting seabirds in Haida Gwai to establish a baseline estimate of nesting seabird populations for monitoring future population trends, and to identify current and potential threats. For the burrow-nesting Ancient Murrelet, this involved counting the number of burrows within sample plots along transects distributed systematically throughout the colony. Extrapolating the average density of burrows from these plots to the entire colony gives an estimate of the total number of burrows within the colony. Adjusting for the percentage of burrows in which breeding occurred provides an estimate of the breeding population in that particular year.

To repeat this census for all colonies of burrow-nesting seabirds in Haida Gwaii would be prohibitively expensive and time-consuming. As an alternative, representative monitoring plots were permanently marked and mapped out on three of the large colonies of Ancient Murrelets that lie within Gwaii Haanas National Park Reserve (Ramsay, George and Rankine islands – Fig. 10). Repeat counts of the burrows within these plots should provide a trend in the breeding population of those colonies. To date, only George and Ramsay islands have been revisited.

In addition to repeat visits to the permanent monitoring plot islands, a number of other colonies have been completely re-censused since initial visits in the early part of the 1980s. Further studies were made of two small colonies in Laskeek Bay, on the northern edge of the breeding range on the east side of Haida Gwaii. Indices of numbers of chicks departing from the colony have been obtained annually or peri-

cifically since 1986 (Reef Island) and 1990 (East Limestone Island) (Gaston and Lemon 1996). The latter island is monitored by a local volunteer organization, the Gwaiee Haanas Conservation Society.

Changes in breeding population and monitoring indices suggest a wide range of trends among island populations, from -23% per annum at Helgesen Island to +9.5% at Lihou Island. All estimates for colonies without introduced predators suggest increases in the breeding population ranging from 0.2 to 9.5% annually. However, changes at colonies where rats and raccoons have been, or still are, present were all negative, with annual rates of decrease ranging from -1 to -23% (Table 3). The greatest losses took place at Langara Island, where approximately half of the 80 000+ burrows present in 1981 were gone by 1993 (Harfenist 1994). There was evidence in both years of heavy predation on Ancient Murrelet adults and eggs by Norway Rats (*Rattus norvegicus*). This colony may have supported as many as 400 000 breeding pairs earlier in the century (Gaston 1992).

Decreases also occurred on Helgesen and East Limestone islands, both affected by raccoons, and Dodge Point, Lyell Island, where Ship Rats (*Rattus rattus*) were abundant in the colony area in 1992. On Helgesen Island and Dodge Point, as well as on Langara Island, the decrease in numbers of Ancient Murrelets has been accompanied by a sharp contraction in the area of the colony. A similar area contraction was observed for a colony on Kunghit Island, which diminished from 44 to 11 ha between 1986 and 1993 (Rodway et al. 1988; Harfenist 1994). Although there was no census in 1986, the

Figure 10. Map of Haida Gwaii, locating islands mentioned in the text.

Table 3. Census and monitoring of Ancient Murrelet populations in Haida Gwaii.

Colony census	1980	1981	1982	1983	1984	1985	1986	1988	1989	1991	1992	1993	1995	1996	1998	Annual change	References
Colony																	
Reef I*						7845							10465			2.90%	Gaston and Lemon 1996
E. Limestone I.*				2378					2850				2122			-1.89%	"
Dodge Pt., Lyell I.			10606								8332					-2.25%	Lemon 1993a
George I.						11614								17384		3.70%	Lemon 1987
Langara I.*		82650						63150				41220				-6.65%	Harfenist 1994
Frederick I.	68457														70321	0.20%	Lemon, unpub.
Helgesen I.							6804					1139				-23.00%	Gaston and Wiacek 1997
Lihou I.							8452					12140				9.56%	"
Kunghit I.*							44.2					11.1				-18.02%	Harfenist 1994
Monitoring plots																	
Ramsay I.*					206						252					2.60%	Lemon 1993b
George I.*						258				327				367		3.36%	Lemon 1987

* Counts or estimates of burrows, other figures are breeding population estimates in pairs of birds, except (+) colony area in ha.
numbers for Frederick Island in 1998 are provisional, pending reanalysis of colony area.
data from 1980 - 1988 for whole colony censuses are from Rodway et al. 1988, 1990 and 1994.
All estimates suggest increases ranging from 0.2-9.9%, annually except where there are extreme rats (Langara, Lyell, Kunghit), or raccoons (East Limestone, Helgesen).

contraction in colony area suggests a substantial decrease in population; rats are present on the island.

Trends based on colony censuses on Reef and East Limestone islands were very similar to those based on chick departures monitored annually at the same colonies, suggesting an increase of approximately 40% between 1985 and 1995 on Reef Island and an approximate decrease of 25% between 1989 and 1995 on East Limestone Island (Fig. 11).

To address the declining seabird populations on Langara Island, Gary Kaiser of CWS Pacific and Yukon Region and Rowley Taylor, an expert from New Zealand, began a rat eradication program in 1993. As of 1998, there was no evidence of rats on the island (Kaiser *et al.* 1997) which we hope will allow for the return of a vibrant breeding population of Ancient Murrelets and other seabirds. Unfortunately, the other islands with colonies plagued by rats (Kunghit, Lyell) are very large; eradication does not appear a realistic prospect and these colonies may soon disappear.

Unlike rats, raccoons are able to cross stretches of open water, but appear to be limited to crossings of less than 0.6 km (Gaston and Maselink 1997). However, this means that about half the Ancient Murrelet colonies in Haida Gwaii are vulnerable to raccoon invasion. In addition to East Limestone Island and Helgesen Island, burrow-nesting auks have disappeared altogether from several small islands invaded by raccoons.

On East Limestone Island and on adjacent coasts of nearby Louise Island, raccoons were controlled by shooting in 1992 (BC Ministry of Environment) and have been culled periodically since then. This probably accounts for the apparent stabilization of the Ancient Murrelet population on East Limestone Island since 1992. In addition, a collaborative agreement between the Canadian Wildlife Service, Parks Canada, the Laskeek Bay Conservation Society and the BC Ministry of Environment, Lands and Parks resulted in a scheme for annual monitoring of colony islands potentially vulnerable to raccoons. Appropriate eradication measures will be taken when raccoons are detected. A campaign of shooting between 1993 and 1997 led to the elimination of raccoons by 1997 on Helgesen Island. We hope populations of burrow-nesting auks (Ancient Murrelets, Rhinoceros Auklet (*Cerorhinca monocerata*), and Cassin's Auklet (*Ptychoramphus aleuticus*)) will recover in due course.

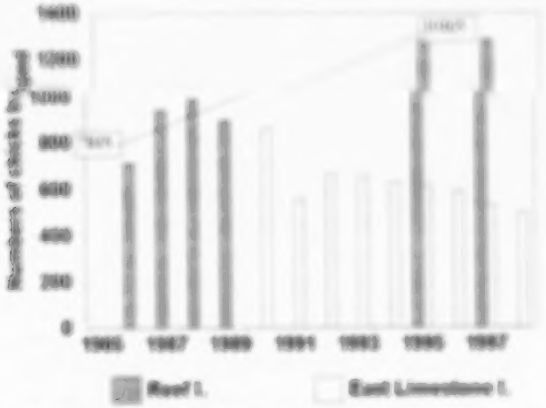

Figure 11. Numbers of chicks trapped at standard catching sites on East Limestone and Reef islands, in comparison with trend estimated from colony census at Reef Island (solid line). These two colonies, although only 6 km apart appear to be behaving differently. Raccoons were present at East Limestone Island until recently, but have not been recorded at Reef Island.

The impact of introduced predators on breeding populations of seabirds can be swift and devastating. Removal of these predators from the entire Haida Gwaii archipelago is not likely feasible, so it is imperative that they be prevented from gaining access to the offshore islands that support nesting seabirds. This will require continued vigilance on the part of the agencies responsible. The active support of amateur naturalists, especially boaters and kayakers who can reach otherwise inaccessible islands, can be very valuable. The Laskeek Bay Conservation Society, in collaboration with the Haida Gwaii Museum, has done much to educate residents and visitors to Haida Gwaii about the menace to native seabirds posed by rats and raccoons. A high degree of participation and collaboration has developed among governments and the public on this issue and the prospects for maintaining populations of Ancient Murrelets appear much better than they did 10 years ago. This is especially welcome given the large proportion of the world population represented in Haida Gwaii.

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Report from Triangle Island Seabird Research and Monitoring Station: Changes in the 1990s

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Triangle Island is the largest seabird colony in BC with the world's largest population of Cassin's Auklet (*Ptychoramphus aleuticus*) (548 000 breeding pairs), and significant breeding populations of Rhinoceros Auklet (*Cerorhinca monocerata*) (41 700), Tufted Puffins (*Fratercula cirrhata*) (26 000), and Common Murres (4100) (D. Bertram, unpubl. data). In 1994, the CWS/NSERC Wildlife Ecology Chair at Simon Fraser University established a research and monitoring station on Triangle Island to investigate seabird population trends and their underlying causes. The focus is primarily on the Cassin's Auklet, Rhinoceros Auklet, Tufted Puffin, and Common Murre. There is evidence that populations in the 1990s are experiencing conditions considerably different from those of the 1970s and 1980s. Timing of breeding has advanced significantly for all four species since the 1970s (D. Bertram, unpubl. data). Reproduction has declined for the Cassin's Auklet, and failed completely for the Tufted Puffin in 4 of the last 5 years (Triangle Island Project, unpubl. data). In the 1990s, both Cassin's and Rhinoceros Auklets have performed more poorly than birds at other colonies in BC (D. Bertram, unpubl. data). In contrast to the other species on Triangle Island, murre reproductive performance remains high (D. Bertram, unpubl. data), although there are few data for historical comparison. Estimates of adult annual survival are low for Cassin's Auklet (0.69) and Rhinoceros Auklet (0.82) based upon the first four years of data (Bertram *et al.* 1999b). Significant changes in key prey species are also apparent. For example, the percentage of Pacific Sand Lance has decreased in the nestling diet of the Rhinoceros Auklet since the 1970s while Pacific Herring have increased. Some of the observed patterns are likely related to major advances in the timing of zooplankton availability in surface waters (Mackas *et al.* 1998), and the general decline in nutrients in surface waters on much of coastal BC (Frank Whitney, pers. comm.). Close collaboration with Fisheries oceanographers is ongoing to investigate the effect of temporal and spatial variability in prey populations on reproduction and survival in seabirds on Triangle Island.

Establishing population indices to gauge trends in abundance is a priority. Permanent monitoring plots established by CWS primarily in 1989 were inspected in 1994 and will be resurveyed in 1999. The utility of radar as a novel method for monitoring population trends in nocturnal seabirds is also under investigation (Bertram *et al.* 1999a). The Wildlife Ecology Research Group has begun to establish a solid baseline for evaluating variability in reproduction among Triangle Island's seabirds and plans to continue the program to obtain time-series information on population trends and their causes at time scales relevant to understanding and conserving colonial seabirds.

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The Marbled Murrelet research program in Desolation Sound

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Marbled Murrelets (*Brachyramphus marmoratus)* are found along the Pacific coast of North America from northern California to Alaska. In British Columbia they nest solitarily or in loose associations in large trees of old-growth forest (greater than 100 years old) (Hamer and Nelson 1995). They can nest up to 60 km inland, but require the marine habitat for their food supply, predominantly Sand Lance

(*Ammodytes hexapterus*), on which they forage inshore (or "close to shore")(Carter and Sealy 1990).

It is speculated that populations of Marbled Murrelets are declining due to: the removal and fragmentation of old-growth forest, bycatch in gill net fisheries, recreational usage of the marine habitat, urban development, and oil spills (Carter and Sealy 1984, Nelson *et al.* 1992, Paton 1994, Carter and Kuletz 1995, Fry 1995). These anthropogenic factors combine with an apparently low fecundity and late maturity (Hamer and Nelson 1995) to cause concern for the survival of the species. Marbled Murrelets are classified as threatened or endangered by the US Fish and Wildlife Service in Washington, Oregon and California, and are a nationally threatened species in Canada, with red listing in British Columbia (Federal Register of the USA, Committee on the Status of Endangered Wildlife in Canada 1998). The threatened status of Marbled Murrelets in British Columbia, and the fact that they are thought to be vulnerable to changes in forest ecosystems from forestry practices prompted a multi-disciplinary research program in Desolation Sound (50 04'N, 124 42'W), involving the CWS/NSERC Chair of Wildlife Ecology at Simon Fraser University, the BC Ministry of Forests and the Canadian Wildlife Service. The program was initiated in 1991 and is ongoing. One of its aims is to understand the population dynamics of the species in Desolation Sound, particularly whether the population is increasing, decreasing or stable.

Following five years of intensive banding, a survival estimate of 85% for Marbled Murrelets at Desolation Sound was calculated, and the population is believed to be approximately 5000 birds (Lougheed *et al.* 1998). Data from nests found during radio-tracking have allowed a preliminary estimate of breeding success of 0.4, and an estimated fecundity of 0.3 (Table 4). As time-series and sample sizes continue to grow, estimates of local adult annual survival and fecundity will become more robust. In turn, increased confidence in the estimates will facilitate the development of predictive population models which can be used to rigorously assess the population status of the Marbled Murrelet in the Desolation Sound region of BC.

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Table 4. Estimates of the parameters used to calculate the population status of Marbled Murrlets in Desolation Sound.

Variable	Mean ± standard error	95% confidence intervals
Survival	0.848 0.085	0.60 – 0.95
Predicted (Beissinger 1995)	0.845	0.84 – 0.88
Breeding success rate	0.7	0.52 – 0.82
Hatching success rate	0.68	0.46 – 0.84
Fledging success rate	0.69	0.43 – 0.86
Nest success rate (hatching x fledging)	0.41	0.23 – 0.68
Fecundity (breeding success x hatching success x fledging success)	0.29 ± 0.09	0.16 – 0.46

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Population trends of gulls and Arctic Terns nesting in the Belcher Islands, Northwest Territories

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Little information exists on the population trends of gulls and terns nesting in the Arctic. In 1997, the number of Glaucous Gull (*Larus hyperboreus*), Herring Gull (*Larus argentatus*), and Arctic Tern (*Sterna paradisaea*) nests on the Belcher Islands (56 00'–57 30'N, 79 30'–80 00'W) were surveyed. The Belcher Islands are a complex of island archipelagoes in southeastern Hudson Bay (Fig. 12). Islands range in size from $1m^2$ to $1000 km^2$. This region and its avifauna are well described by Freeman (1970) and Manning (1976). Five archipelagoes were surveyed between 1985 and 1989 to count the number of nests of Common Eiders, Arctic Terns, and large gulls (Nakashima and Murray 1988; McDonald and Fleming 1990, Fleming and McDonald 1987). In these studies, all islands less than 500 ha were numbered within each region, and 50% of these islands were randomly selected for survey.

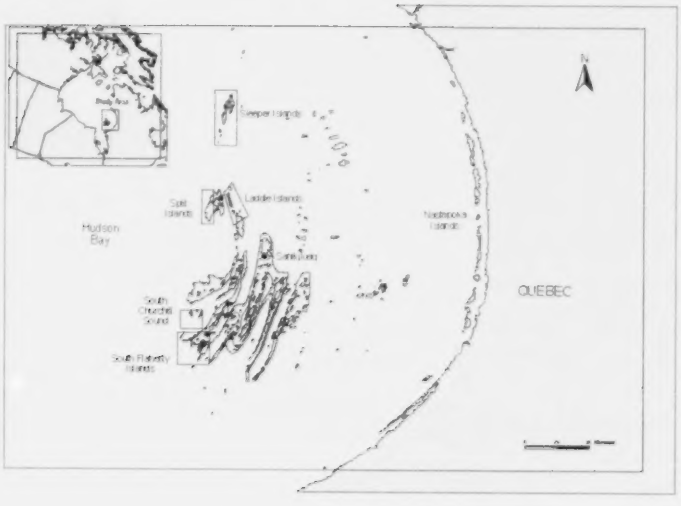

Figure 12. Map of the Belcher Island archipelago, Hudson Bay.

These selected islands were revisited in 1997, and all surveys were conducted in early July at the height of incubation.

Results from 1997 were compared to the mean number of nests per island counted in the Belcher Islands in the late 1980s using the same survey methods. Unfortunately, only summaries of mean nests per island for each region were available for comparisons to 1997 data (originally presented with standard error and island sample size). The ability to detect differences in the nests per island of these species was low, and resulted in a conservative test for differences in the number of nests found (a modified t-test that allowed for unequal variances and sample sizes; Zar 1984, p. 131), to avoid the assumption that the two samples had equal variances. Clearly, island by island comparisons recording gains and losses between the two study periods would have been a much more powerful test of population trends. This comparison was made with Common Eider data (Robertson and Gilchrist 1988).

In all five of the archipelagoes surveyed, the mean number of gull nests per island declined, significantly in three regions (Table 5). The number of Arctic Tern nests also declined in all three regions where they were originally present, although this decline was significant in only one region (Table 6). There are several possible reasons for these findings, which are not mutually exclusive: 1) gulls and terns may have moved to other islands in the Belcher group not surveyed in 1997; 2) there may have been extensive non-breeding by gulls and terns in the region in 1997; 3) birds that were resident and breeding in the 1980s may have emigrated out of the Belcher Islands to nest elsewhere; and 4) fewer adult gulls and terns may have been alive in the local population.

Survey results may be wrongly interpreted as population declines if birds disperse from large colonies and establish small colonies that are difficult to find. However, the surveys covered up to 50% of randomly selected islands in five study regions. Thus, it is unlikely that a sufficient number of islands with high nesting densities were missed to account for the decline. Further, the number of gulls and terns declined in all regions surveyed, with no obvious shift in distribution among regions. In 1997, weather and ice conditions were favorable. Nesting islands

Table 5. Comparison of the number of gull nests per island between the 1980s and 1997 in the Belcher Islands in relation to island group.

	Nests/island			
	1980s	1997	*t*	*P*
South Flaherty Islands	1.04 ± 2.6 (132)	0.6 ± 2.1 (153)	2.12	0.017
South Churchill Sound	3.2 ± 9.3 (27)	1.7 ± 5.7 (27)	0.85	0.2
Sleeper Islands	0.8 ± 2.9 (174)	0.6 ± 1.9 (107)	0.76	0.22
Split Islands	0.7 ± 2.3 (56)	0.2 ± 0.7 (62)	2.08	0.02
Laddie Islands	0.7 ± 1.3 (78)	0.1 ± 0.3 (82)	5.22	0.0001
Total	1.0 ± 3.3 (467)	0.5 ± 2.2 (431)	3.51	0.0002

Table 6. Comparison of the number of Arctic Tern nests per island between the 1980s and 1997 in the Belcher Islands in relation to island group.

	Nests/island			
	1985	1997	*t*	*P*
South Flaherty Islands	5 nests	0	-	-
South Churchill Sound	0	0	-	-
Sleeper Islands	4.3 ± 26.0 (174)	2.0 ± 14.7 (107)	1	0.158
Split Islands	1.4 ± 10.6 (78)	0.9 ± 6.0 (82)	0.47	0.312
Laddie Islands	1.4 ± 5.2 (56)	0.03 ± 0.25 (62)	2.64	0.005
Total	3.0 ± 20.4 (308)	0.6 ± 7.7 (251)	1.91	0.057

and adjacent waters were free of ice early in June, and both gulls and terns nested relatively early. Among gulls, there were very few empty nests found on islands, and mean clutch sizes were well within the norm for the species (Pierotti and Good, 1994). Further, the ratio of the number of gulls flying above islands generally matched the numbers of nests found. These observations were not difficult to make because of the small number of gulls and nests observed on each island. This suggests that there were few non-breeding pairs present on surveyed islands in 1997. However, non-breeding gulls and terns occurring elsewhere in the Belcher Islands (e.g. foraging at sea) may have been missed.

It appears that 1997 was a good breeding year for both gulls and terns in the Belcher Islands. The reduction in the number of nesting females seems to be due to a real numerical decline in the local breeding population rather than redistribution of nesting birds or extensive non-breeding by females within the Belcher Islands.

Causes for these declines are unknown. Interestingly, the greatest declines of both gulls and terns occurred in the regions closest to the community of Sanikiluaq, on the Belcher Islands. This suggests that egging and disturbance may have contributed to regional population declines. Adult mortality or emigration rates of gulls from the area may also have occurred in response to restricted access to marine food sources resulting from changes in polynya formation during recent winters. Reproductive success of gulls may also be low in response to the recent 75% decline in Common Eiders nesting in the Belcher Islands (Robertson and Gilchrist, 1998). Eider eggs and ducklings are an important food source for gulls during the breeding season. The decline of nesting Arctic Terns may reflect winter mortality of tern populations caused by unknown factors, or emigration out of the Belcher Islands in response to regional egging and disturbance by local residents.

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Breeding populations of cormorants, gulls and terns on the Canadian Great Lakes in 1997/98

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During the last 25 years, there have been two Great Lakes-wide censuses of the breeding populations of colonially-nesting waterbirds jointly coordinated by Canada and the US. The purposes of these surveys were to identify the nesting locations of the various species and determine the number of nests of each. These surveys were conducted in 1976-80 and 1989-91 by H. Blokpoel and coworkers (see Austen *et al.* 1996, and Blokpoel and Tessier 1993, 1996, 1997 and 1998 for results and references) on the Canadian side and W. Scharf and coworkers (see Scharf 1998, and Scharf and Shugart 1998 for

results and references) on the US side. In 1997, a third joint Great Lakes-wide survey was initiated. Although this survey has not yet been completed, results to date for the Canadian waters of the Great Lakes are presented here for: Herring Gulls (*Larus argentatus*) on Lake Ontario and portions of Lakes Huron and Superior, and Double-crested Cormorants (*Phalacrocorax auritus*) and Caspian Terns (*Sterna caspia*) on all lakes. Herring Gull nests were surveyed between 15 and 30 May, Caspian Tern nests between 1 and 10 June and Double-crested Cormorant nests from 10 to 30 June. All colonies were surveyed by ground count or boat estimate. The results are based on counts of apparently occupied nests (AONs) at previously known nesting colonies. New colony sites discovered since the last census are not included, except for cormorants on all Great Lakes, Herring Gulls and Caspian Terns on Lake Ontario, and Caspian Terns on Lake Erie. These counts should, therefore, be considered minimum figures; there may have been more nests in 1997/98 than reported here. The remaining colonies will be surveyed in 1999.

Double-crested Cormorants

The number of cormorant nests in known colonies on the Canadian Great Lakes in 1980, 1990, 1994 and 1997 are shown in Table 7; annual overall numbers by lake are shown in Figure 13. From 1990 to 1997, cormorant nest numbers increased in all areas of the Canadian Great Lakes from as little as 34% on Lake Superior to as much as 387% on Lake Erie. Although nest numbers in most areas continued to increase in more recent years (1994–1997) there were notable declines in Georgian Bay (-27%) and the North Channel of Lake Huron (-8%). These declines included the abandonment of at least 5 colonies and a dramatic reduction in nest numbers (-25%) at 6 others. Birds from colonies which were abandoned may have established new colony sites that have not yet been located. The colonies showing the largest declines in Georgian Bay and the North Channel, are West Rock and an island near West Island, respectively. The condition of these colonies when visited (i.e. many nests, but few with contents or signs of upkeep) suggest human vandalism early in the season.

In 1998, only colonies in the St. Lawrence River (3 sites with 843 nests; 16% increase since 1997) and Lake Ontario (15 sites with 12 992 nests; 49% increase since 1997) were censused. Most of the increase on Lake Ontario resulted from an increase of 3500 nests on three colonies; a single new colony in 1998 contributed little.

Table 7. The number of Double-crested Cormorant nests at all known colony sites in the Canadian Great Lakes for selected years. Number of active cormorant colony sites censused in parentheses(). All data from D.V. Weseloh (unpubl.).

Year	1980	1990	1994	1997
Location				
St. Lawrence R.	0	0	292(2)	727(3) [149][1]
Lake Ontario	99(2)	2593(8) [2519]	6241(12) [141]	8691(14) [39] {235}[2]
Lake Erie	114(1)	1807(3) [1485]	4721(3) [161]	8814(3) [87] {387}
Lake Huron				
Main Body	0	1775(6) —	2300(5)3 [30]	3747(6) [63] {111}
Georgian Bay	176(4)	4017(26) [2182]	10 369(34) [158]	7547(32) [-27] {88}
North Channel	159(5)	4179(12) [2528]	6766(16) [62]	6255(16) [-8] {50}
Lake Superior	80(4)	1485 (15) [1756]	1648(16)[3] [11]	1985(16)[4] [20] {34}
Totals	628 (16)	15 856(70) [2425]	32 013(88) [102]	36 498(90) [14] {130}

1. [percent change since previous survey]
2. {percent between 1990 and 1997}
3. data for 1993
4. data for 1996

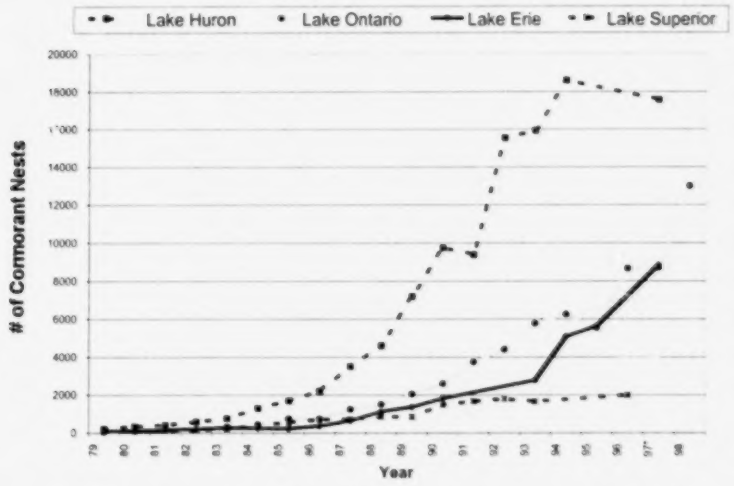

Figure 13. Annual overall numbers of Double-crested Cormorants in the Canadian Great Lakes by lake.

The areas showing rapid increase in nest numbers of late are either recently colonized (St. Lawrence River) or older colony sites which possess much unexploited habitat (the treed islands of Lake Erie; selected islands on Lake Ontario). The initial resurgence of cormorant numbers in the Great Lakes following the ban of DDT was attributed to declining contaminant levels and an abundant food supply (Price and Weseloh 1986). Recent increases appear to result more from expansion into new habitat, given that contaminant concentrations in cormorant eggs have been below critical levels for some time (Ryckman *et al.*1998).

Herring Gulls

On Lake Ontario, 68.8% of the colony sites known in 1990 were surveyed in 1998. Results show that nest numbers increased 6.5% over that time (Table 8). The data suggest that, as of 1998, Herring Gull populations on Lake Ontario are at least stable and probably growing slowly, compared to the dramatic increase between 1976 and 1990 (Blokpoel and Tessier 1996).

On Lake Huron, where only 5.1% of the colony sites known in 1989 were surveyed, nest numbers had declined by -14.2%. No searches for new colony sites were made. Blokpoel and Tessier (1997) found that Herring Gull populations there had declined by -19.9% between 1980 and 1989. Recent data, though limited, suggest that the population is still declining.

On Lake Superior (Area 3, Blokpoel and Tessier 1993), 61.5% of the colony sites known in 1989 were surveyed, and nest numbers declined by -39.1%. For this portion of Lake Superior, Blokpoel and Tessier (1993) reported a population decline as well.

Herring Gulls nesting in Lake Superior had poorer body condition and smaller clutch volumes than gulls on Lakes Erie and Ontario. Their pellets also contained many more insect remains than did pellets from the lower lakes (L. Shutt, CWS, unpubl. data). McNicholl *et al.* (1983) documented cannibalism on chicks by neighbouring pairs as the main cause of poor reproductive success on a Herring Gull colony in eastern Lake Superior. It occurred when both members of a pair left their territory, presumably to find food for their chicks. Herring Gulls on Lake Superior appear to have been under food stress for several years, which may now be affecting the size of the breeding population on at least a portion of the lake.

Caspian Terns

In Lakes Ontario, Erie and Huron, all known Caspian Tern colonies were visited, however no searches for new colonies were undertaken. Caspian Terns are not known to nest in Lake Superior.

On Lake Ontario, the number of Caspian Tern nests increased by 31.8% overall, or 3.5% per year (Table 9). Large increases in tern nest numbers were found on Gull Island (from 102 to 442) and at Hamilton Harbour (from 184 to 433). New colonial waterbird habitat was created recently in Hamilton Harbour (Pekarik *et al.* 1997); terns have completely vacated their old nesting habitat in the harbour and, presumably, moved to the new. In contrast, numbers declined at Pigeon Island from 479 to 130. This may represent gradual abandonment of this site by Caspian Terns in favour of the much larger colony on Little Galloo Island, New York, 24 km to the south, which had over 1200 nests in 1997 (D.V. Weseloh, pers. obs).

In both Georgian Bay and the North Channel of Lake Huron, tern nest numbers declined respectively by -35.5% and -44.0 % overall, or -4.8% and -6.2% per year. Numbers declined at most colonies on Lake Huron, and the colonies on North Watcher Island and Halfmoon Island were abandoned. The reasons for the abandonment are not known, though the birds could simply have moved to new sites not yet discovered.

On Lake Erie, the colony active at Mohawk Island in 1996 (78 nests, D.V. Weseloh, pers. obs.) was not active in 1998. This colony was new in 1996 and was located close to the water's edge. The marginal nature of the habitat, and the possibility of human disturbance at such a new site, may have led to the abandonment.

Conclusion

Colonial waterbird populations on the Canadian Great Lakes are numerous. Cormorants are abundant and their numbers seem to be increasing still, though not as rapidly as in previous years. Herring Gulls and Caspian Terns have declined in some areas of the Canadian Great Lakes, although at this time their lakes-wide populations are not known. Caspian Terns, especially, may be shifting their population centres to colony sites on the US side of the lakes. A complete Great Lakes survey will soon be available.

Acknowledgements

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Table 8. Number of Herring Gull nests on selected colonies in Lakes Ontario, Huron and Superior in 1989-90 and 1989. The number of colonies surveyed is given in parentheses. Data for 1989-90 are from Blokpoel and Tessier (1993, 1996 and 1997).

Location	1989/90	1998	Overall % change (Annual rate of change)
Lake Ontario (16)	889	947	6.5% (0.8%)
Lake Huron (22)	7204	6178	-14.2% (-1.7%)
Lake Superior (40)[1]	1722	1048	-39.1% (-5.4%)
Totals	**9815**	**8178**	**-16.7% (-2.0%)**

1. All colonies are from Area 3 (Wawa) from Blokpoel and Tessier (1993 8)

Table 9. Number of Caspian Tern nests on all known colonies in Canadian Great Lakes in 1989-90 and 1998. The number of colonies surveyed is given in parentheses. All data for 1989-90 are from Blokpoel and Tessier (1993, 1996 and 1997).

Location	1989/90	1998	Overall % Change (Annual rate of change)
Lake Ontario (6)	765	1008	31.8% (3.5%)
Lake Huron			
-Georgian Bay (4)	1692	1091	-44.0% (-4.8%)
-North Channel (2)	603	338	-35.7% (-6.2%)
Totals	**3,060**	**2,437**	**-20.4% (-2.5%)**

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Implications of the tern census on Machias Seal Island

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Machias Seal Island is a Migratory Bird Sanctuary situated on the border between the Gulf of Maine and the Bay of Fundy. Breeding seabirds include Atlantic Puffin (*Fratercula arctica*), Razorbill (*Alca torda*), Leach's Storm-petrel (*Oceanodroma leucorhoa*), Common Eider (*Somateria mollissima*), Common Tern (*Sterna hirundo*) and what is apparently the largest North American colony of Arctic Terns (*S. paradisaea*) (Devlin and Diamond 1999). A census of tern nests is carried out every second (even-numbered) year by CWS staff, and personnel from Acadia University and the University of New Brunswick. Common and Arctic Tern nests cannot be distinguished, so the ratio of the two species is estimated from counts of adults on the ground taken from several observation points around the island by the CWS warden.

The accuracy of the species-ratio is particularly important for Arctic Terns as this colony accounts for 46% of the Arctic Tern population of the Gulf of Maine. The population was estimated at 4524 pairs at 9 sites in 1998, a 43% increase in pairs since 1984, but at half the number of sites (Koch 1998). The ratio is less important for Common Terns, representing 12% of a Gulf breeding population for 1998 estimated at 7392 pairs at 22 sites. This is an increase of 190% at 6 fewer sites compared to 1984. Calculating both the total number of Arctic Tern pairs in the Gulf breeding population, and the proportion nesting at Machias Seal, obviously depends on an accurate estimate of the species ratio on Machias Seal.

The species ratio was assessed by CWS warden Jason Hudson in 1994, and annually from 1996-1998 (Table 10). In each year, new counting points were used to achieve more representative coverage of the island. The estimated proportion of Common Terns has increased from 5–6% to around 30%, significantly reducing the Arctic Tern population estimate not only

for Machias Seal but for the whole Gulf of Maine. To assess whether the ratio really has changed during this period, only counts made from the points used in each year (n=3, Table 10) were compared. These suggest that the proportion of Common Terns increased by a factor of about 2.5 times between 1994 (5.5%) and 1996-1998 (weighted mean 13.9%). It is of course possible that the nesting distribution, rather than the number of birds, changed, but this possibility cannot be tested at present.

The question remains whether the 'true' proportion of Common Terns is closer to the ~14% indicated by the three points counted in each year, or the ~28% (weighted mean for all three years) indicated by counts from the larger number of points. It may seem reasonable to assume that the larger number of points used since 1996 (and spread more widely around the island) is more representative of the colony as a whole, but this assumption must be tested. In 1998, an indirect test was conducted by examining the species ratio in tern chicks banded in a systematic search of almost the entire island (excluding only intensive-study plots). Of the 318 chicks in the sample, 72 or 22.6% were Common Terns. Species are distinguished using growth data from intensive-study plots: among chicks with wing-length ≥50mm, those with tarsus length ≥17 mm are Common Terns, and those with tarsus length <17mm are Arctics (Diamond *in* Koch 1998). This method probably underestimates the proportion of Common Terns as they nest slightly later, resulting in a higher proportion of chicks that are too small to band or identify. Nesting areas used by Common Terns also overlap more with those of alcids; they may suffer greater mortality from interference by puffins and razorbills en route to and from their nests (Diamond *in* Koch 1998). The proportion of 23% Common Terns in the sample of banded chicks is not contradictory to the 28% indicated by the weighted mean of the recent counts of adults (above).

Clearly this assumption must be tested more directly to allow changes in the numbers of Arctic and Common Terns to be tracked with more confidence. A 30m reference grid has been staked out on the island, and future censuses, species-ratio counts, and numbers of chicks banded will be recorded by grid square. Meanwhile, the preliminary conclusion is that the proportion of Common Terns nesting on Machias Seal Island increased by about 2.5 times between 1994 and 1996, and represented about 28% of the whole colony from 1996 through 1998.

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Table 10. Proportion of Common Terns counted on Machias Seal Island in recent years (J. Hudson, pers. comm.).

	YEAR			
3 constant points	**1994**	**1996**	**1997**	**1998**
N (birds)	237	110	172	187
% Common	5.5	11.8	16.3	12.8
All points (n)	8	7	9	13
N (birds)	363	266	383	580
% Common	6.6	27.1	26.1	30

Trends of chronic oil pollution in southeast Newfoundland assessed through beached-bird surveys 1984-1997

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Introduction

Over 30 million pelagic seabirds are estimated to reside or migrate annually through the waters around Newfoundland. Unfortunately for them, the island of Newfoundland lies near major shipping routes connecting Europe and North America, many of which converge off Cape Race at the southeastern tip of the island. This exposes birds to spilled oil; chemical analysis of oil samples taken from beaches and from stranded birds show that 90% contain heavy fuel oil, the type used by large ocean-going vessels in North Atlantic waters (A.R. Lock pers. comm.). Aircraft sightings of vessels discharging oil at sea in the waters off Newfoundland provide further evidence that this source of pollution recurs in many areas of seasonal importance to marine birds (P. Ryan pers. comm.). Most of the species at risk are long-lived and show little capacity to recover from high mortality rates.

Oil at sea is a threat to seabirds because it can form a thin layer on the water surface where many birds are found. The hydrophobic nature of oil causes plumage to lose insulation, waterproofing, and buoyancy. In addition, petroleum oils contain many toxic compounds that, when ingested or inhaled, can lead to fatal or debilitating effects (Leighton 1990). These factors combined with the severe winter conditions prevalent in Newfoundland waters mean that dead and live oiled seabirds have washed up on Newfoundland's shores for many years (Tuck 1961, Platt *et al.* 1985). Most past studies have focused on the effects of large oil spills on seabirds, but chronic oil pollution may be as or more important to long-term population dynamics (Hunt 1987, Burger 1992).

Systematic beached bird surveys have been carried out in southeast Newfoundland since 1984, but there are records of oiled birds from beach surveys in the 1960s and early 1980s (Tuck 1961, Threlfall and Platt 1982). The current survey regime was designed to determine general trends in the proportion of oiled seabirds found (R.D. Elliot pers. comm.), but, combined with other information, results can be used to estimate the number of seabird casualties following an oiling event. Factors such as drifting patterns, sinking and scavenging rates of oiled birds, and the persistence and detection rate of beached

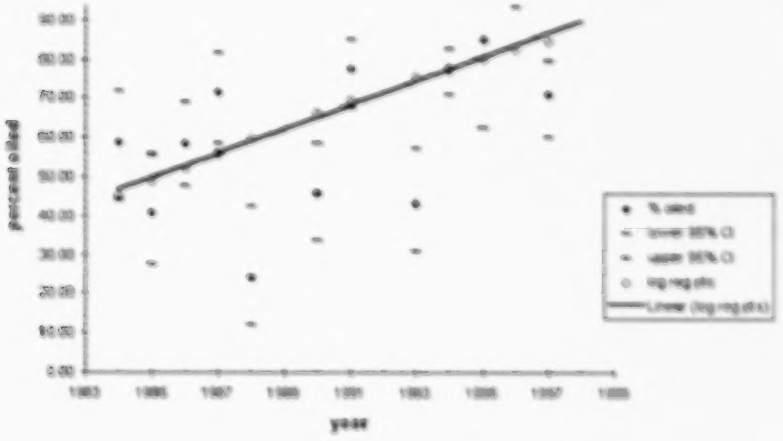

Figure 14. Change in proportion of oiled birds, 1984-1997 (n = 965). Numbers above points indicate sample sizes.

corpses affect the estimate of total seabird mortality from oil pollution. Nevertheless, beached bird surveys yield valuable information on seasonal and environmental effects, differences in the degree to which species are affected, and trends in oiling over the years.

To assess annual trends in the proportion of oiled birds found, a subset of the data from all surveys is used that includes observations of 965 birds coded for oil (0–3) found during a total of 324 visits to 9 beaches in the months October through March.

Trends in the proportion of oiled birds 1984 - 1997

Analysis of results reveals an overall oiling rate of 70.98% (Fig. 14), and a yearly increase of 3% ($P=0.0001$) in the proportion of oiled birds over the last 13 years, with significant differences ($P=0.0001$) between years. Survey effort (the number of surveys per month) has increased, but not significantly; the increase in the proportion of oiled birds is assumed to be real rather than due to increased effort.

Changing bird distributions, larger proportions of vessels illegally discharging oil at sea, and/or increased shipping activities during the period of the study could all play a part in the increase of oiling rates; they warrant further investigation. In addition, efforts to reduce marine pollution via enforcement and education have increased (POW Report 1998), but their effectiveness is undetermined.

Despite the overall increase in oiling rates, the survey results show marked yearly variations in the number of birds found on beaches, both oiled and not oiled. Time and location are critical factors when estimating the impact of oil released into the water on seabirds. Some of the survey beaches face different bodies of water, are exposed to different wind patterns and local currents, or have different use by marine birds (Fig. 15). CpShoreW and SAvalon differ in both oiling rate (78.22% vs. 56.86%) and its yearly increase (2.8% per annum vs. 2.2% per annum). Different arrival times for over-wintering species, irregularities in shipping activities, and different weather conditions among years may all play a role in the observed yearly variations in the proportion of oiled birds.

Trends of different bird groups and individual species

Most of the birds found on beaches normally spend much of their life at sea, and feed on or under the water. For this analysis, species were grouped according to their principal feeding habits and average

Figure 15. Map of the Avalon, showing the location of beaches used in the analysis.

distance from shore. Results indicate that species differ in the proportion of birds oiled ($P=0.0001$) (Table 11). As found in studies elsewhere (Camphuysen 1989, 1998, Simons 1985), diving ducks and alcids are the groups most affected by oiling in Newfoundland.

The "alcids" are pursuit-diving sea birds and include Common (*Uria aalge*) and Thick-billed Murres (*U. lomvia*), Atlantic Puffin (*Fratercula arctica*), Black Guillemot (*Cepphus grylle*), Dovekie (*Alle alle*), Razorbill (*Alca torda*) and birds identified only as alcids. This group had the highest oiling rate (61.13%) and is the only group to show an annual increase in the proportion of oiled birds (2.67%). These birds represent 89% of the corpses found on which oil was reliably detected. Common, Thick-billed and unidentified Murres make up 71.9% of the alcids and 63.3% of all birds coded for oil during the 11 year period. Overall, 76.9% of murres found were oiled, clearly the group most affected by oiling. This ratio was slightly higher for the Grand Banks (81%), and lower in St. Mary's (70%) and Placentia (62%), with an overall annual increase of 2.2% in the proportion of oiled murres found. If this trend continues, 90% of murres would be oiled by the 1998 season, the highest oiling rate in the world (Camphuysen 1998). Alcids are likely found in large numbers on survey beaches because they are especially abundant in Newfoundland waters during winter. Thick-billed Murre and Dovekie are particularly at risk as they spend considerable time on or under the surface near offshore shipping lanes. Both species reflect the overall yearly increase in the proportion of oiled birds (4.1% and 2.7% annual increases, respectively). Common Murres, on the other hand, show no linear change over the years, nor is the proportion of oiled birds different among years. This result warrants further investigation.

Sea ducks spend most of their time relatively near shore foraging or resting, and are nearly always in the water. The species found commonly in this region are relatively sedentary once established at traditional wintering sites in eastern and southern Newfoundland. Sea ducks and alcids are known to dive as an escape response, behaviour which makes them more vulnerable to oil at sea than species more likely to evade a slick by taking flight. Not surprisingly, "ducks" such as eiders and Oldsquaw had a fairly high oiling rate of 47.5%.

Coastal and/or highly aerial species such as, Northern Fulmars (*Fulmarus glacialis*), Black-legged Kittiwakes (*Rissa tridactyla*), shearwaters (*Puffinus* spp.), and Northern Gannets (*Morus bassanus*) (labeled "others") appear to be least affected by oil (7.2%). "Gulls", including Great Black-backed (*Larus marinus*), Herring (*L. argentatus*), Glaucous (*L. hyperboreus*), Iceland (*L. Glaucoides*) and unidentified gulls, had an oiling rate of 12.5% overall. Gull species spend more of the year near shore and on land, including time near sources of shore-based oil pollution, and may also spend more time sitting on the water than do "others". Both factors would make gulls more vulnerable to spilled oil, and may explain their higher oiling rates. The larger gulls may be contaminated when they predate and scavenge injured and oiled birds. While all birds actively preen petroleum oil from their feathers if not debilitated (Corkhill 1973), the terrestrial habits of gulls may lead to greater success in removing external oil. As few corpses were autopsied, beach survey results could not determine whether unoiled birds suffered from oil ingestion.

Table 11. Comparison of the proportion of oiled birds between different bird groups in different seasons. In the table n refers to the total number of birds coded for oil.

seasons	alcids % (n)	ducks % (n)	gulls % (n)	others % (n)	total % (n)
summer	15.12 (256)	50.00 (6)	8.00 (125)	4.96 (343)	9.43 (732)
winter	74.25 (905)	47.06 (34)	33.33 (27)	50.00 (18)	71.75 (984)
total	**61.13 (1163)**	**47.50 (40)**	**12.50 (152)**	**7.2 (361)**	**45.16 (1716)**

Effects of season

Winter (October to March) has significantly higher proportions of oiled birds ($P<0.0001$) than summer (April to September) (61.5 % vs. 8.5 %). This seasonality holds true for each year ($P<0.0001$), and each region ($P<0.0001$). December frequently shows a higher proportion of oiled birds than other months, averaging 87.1%. All groups, except murdocks, show strong seasonal effect (Table 11), but each group differs in both number and proportion affected in each season ($P<0.0001$). Alcids have the strongest seasonal effect, and are clearly the most affected in winter in both percentage and total number.

Of the 32 species found throughout the year, only 5 (Black-legged Kittiwake, Common Murre, Dovekie, Herring Gull, and Thick-billed Murre) had sample sizes large enough for statistical analysis. Species differed in their year-round proportion of oiling ($P<0.0001$), ranging from 70% in Thick-billed Murre and Dovekie to as low as 5% for Black-legged Kittiwake. In addition, each species, except Common Murre, showed a marked seasonality, both in presence (n) and proportion oiled (%) (Table 12).

Seasonal differences in the number of oiled birds may be caused by the colder sea and air temperatures in winter, increasing the thermal stress on affected birds. Winter also offers greater cover of darkness during which unscrupulous mariners could dump oil at sea with little risk of detection. Stormy weather could necessitate more frequent discharge of oily bilge and ballast water. Sea ice in Belle Isle Strait may divert transatlantic vessels to the south of Newfoundland in winter, which would increase the total volume of traffic, as well as the potential for bird oiling within the survey region (Bourne and Bibby 1975, Stowe and Underwood 1984, Chardine 1990).

Oiling mortality might be overestimated by including birds oiled post-mortem in the samples retrieved from beaches. Vauk *et al.* (1990) however, found that 20% of carcasses lacking external oil had internal contamination. Whether scavenging rates and buoyancy of oiled versus unoiled birds differ is under investigation, but these factors would also influence the detection rate.

Conclusion

Analysis shows that a high proportion of birds found were oiled, and, most alarmingly, that this oiling rate has consistently increased during a period when the technology and legislation dedicated to reducing the effects of marine pollution have improved. The risk of oil pollution will likely increase with continuing exploitation of Canadian offshore oil fields. Chronic marine oil pollution, most evident and severe through its effect on marine birds, should not be allowed to continue. Mariners, operators of large and small vessels and those with financial and direct influence over the activities of ships and facilities that extract or handle oil are most responsible to ensure that this problem is resolved.

Beached bird surveys are a useful tool for assessing trends in oiling and mortality after oiling events. However, implementing the following recommendations would improve the power of current beached bird surveys: (1) focus surveys on beaches with historical data, to allow the determination of long-term trends; (2) increase efforts in Labrador to facilitate regional comparison; (3) conduct beached carcass persistence studies to assess the amount of information lost through monthly surveys, the degree of movement of beached birds between beaches, and the influence of scavengers on the proportion of oiled birds retrieved; (4) conduct experiments to determine the fate of birds at sea, scavenging and sinking rates at sea for oiled and non-oiled birds, and buoyancy differ-

Table 12. Comparison of the proportion of oiled birds between different species in different seasons. In the table n refers to the total number of birds coded for oil.

season	TBMU % (n)	DOVE % (n)	COMU % (n)	HERG % (n)	BLKI % (n)	total % (n)
summer	52.63 (19)	25.00 (8)	0.51 (195)	7.55 (106)	2.80 (214)	7.17 (542)
winter	78.38 (296)	72.94 (218)	63.08 (130)	42.86 (14)	93.33 (6)	72.89 (664)
total	76.83 (315)	71.24 (226)	31.10 (298)	11.67 (120)	5.00 (220)	44.15 (1160)

TBMU = Thick-billed Murre, DOVE = Dovekie, COMU = Common Murre, HERG = Herring Gull, BLKI = Black-legged Kittiwake

ences between oiled and non-oiled birds, (5) perform necropsies on whole birds stranded with no external sign of oiling to establish the cause of death; and (6) analyze weather patterns and shipping activities to determine the major causes of the detected oiling trends and to explain the variations observed between years and regions.

Acknowledgements

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Seabirds at Risk in Canada

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Six seabird species are listed in the April 1998 "Canadian Species at Risk" document prepared by COSEWIC, the Committee on the Status of Endangered Wildlife in Canada. The Roseate Tern (*Sterna dougallii*) and Marbled Murrelet (*Brachyramphus marmoratus*) were designated threatened in 1986 and 1990, respectively. The four other species were all designated vulnerable: the Caspian Tern (*Sterna caspia*) in 1978, the Ancient Murrelet (*Synthliboramphus antiquus*) in 1993, and the Ivory (*Pagophila eburnea*) and Ross' gulls (*Rhodostethia rosea*) in 1996. Summaries of the recovery efforts for the two threatened species appear in the 10-year anniversary report of RENEW (the committee on the REcovery of Nationally Endangered Wildlife).

An "Endangered" species is one that faces imminent extirpation or extinction, a "Threatened" species is likely to become endangered if limiting factors are not reversed, and a "Vulnerable" species is of special concern because of characteristics that make it particularly sensitive to human activities or natural events.

The Roseate Tern breeds locally on coasts and islands on both sides of the Atlantic Ocean. In Canada, between 100 and 125 pairs breed in colonies along the coast of Nova Scotia and, to a lesser extent, Quebec. This represents about 3–4% of the total population in eastern North America. The number of Roseate Terns in eastern Canada has probably always been relatively small, but there is strong evidence that the population has declined rapidly since the early 1950s. Predation by a variety of avian and mammalian species, and interference at breeding colonies by large gulls are major factors limiting the size and distribution of the Roseate Tern population in Canada. Commercial trapping of terns in their wintering grounds along the north shore of South America may also be contributing to the decline of this species.

The recovery plan for the Roseate Tern was approved in 1992. It includes a coordinated program of population and habitat surveys, monitoring reproductive success, banding to determine movements, nest box placement to provide cover, and public education, but, as of 1997, had not resulted in an increase in the number of Roseate Terns breeding in Canada. Furthermore, data gathered from two essential colonies in Nova Scotia suggest that productivity of Roseate Terns in Canada is well below the goal of one fledgling per pair per year. Further recovery actions are imperative for this species.

The ecology of the Marbled Murrelet is now much better understood (see Hull, p. 26) than it was when the recovery plan for the species was approved in 1993, but loss of nest sites continues to be a concern. Draft management guidelines to preserve nesting habitat for the Marbled Murrelet have been submitted to the BC government, but they have yet to be implemented. Through an amendment of the Forest Practices Code in February 1999, the BC government will implement a provincial Identified Wildlife Management Strategy in phases. Under this strategy, Wildlife Habitat Areas for this species would be identified. A coordinated, province-wide coastal census is needed to obtain a more accurate estimate of the population size of the Marbled Murrelet in British Columbia.

Breeding sites of the Caspian Tern are widely scattered across North America and around the world. In Canada, breeding colonies are found in six provinces and the Northwest Territories; the terns are casual visitors to other parts of the country. Most colonies are dense aggregates of 50 to 1000 pairs. The largest colonies, which account for 95% of the total Canadian population of about 5200 pairs, occur in Ontario and Manitoba (see Weseloh *et al.*, p. 30). The breeding range of the Caspian Tern does not appear to have changed, but local populations have fluctuated. The main threats to this species are human disturbance at the colonies, especially during the early stages of breeding, and pollution of the water in which the terns hunt fish.

Control of introduced predators on offshore nesting islands is the greatest challenge facing those working to conserve the Ancient Murrelet. This is not feasible on all islands, however, lending even greater importance to those colonies that are predator-free (see Lemon and Gaston, p. 22).

The Ivory Gull was designated vulnerable in 1979 and again in 1996, when its status was re-evaluated by COSEWIC. An estimated 35 000 Ivory Gulls winter in the northwest Atlantic, based on aerial censuses over Davis Strait. In 1979, the breeding population in the Canadian Arctic was estimated at about 2000 individuals; in 1996, the estimate was 2400 adults. After the 1979 status report was written, seven additional colonies of Ivory Gulls were discovered in the Arctic archipelago, bringing the Canadian total to 10 known, active colonies. Its specialized nesting requirements and intolerance to disturbance on the nesting grounds make the Ivory Gull vulnerable to oil and natural gas development in the Arctic.

COSEWIC re-evaluated the status of the Ross' Gull in 1996, retaining the 1981 designation as vulnerable. The Canadian population of this circumpolar species has probably always been small. The only two known breeding locations in Canada are on the Cheyne Islands in Penny Strait, NT, and in the Hudson Bay lowlands, near Churchill, Manitoba. The Churchill population has ranged from one to five pairs since 1980, and no more than seven adult pairs have been found on the Cheyne Islands. The low breeding success at Canadian locations is characteristic of this species, and is due to predation, bad weather and various types of human disturbance. Given the Arctic's vastness and severe weather, some breeding sites may remain undetected. Recent censuses of the main breeding grounds in Siberia suggest the world population of the Ross' Gull may be 50 000 individuals.

References

Status reports for each of the six species covered in this article, recovery plans for the two threatened species, and the tenth anniversary RENEW Report No.8, can all be obtained from the COSEWIC Secretariat, c/o Canadian Wildlife Service, Environment Canada, Ottawa, ON, K1A 0H3, Tel: (819) 997-4991, Fax: (819) 994-3684, email: Sylvia.Normand@ec.gc.ca

Menu of volunteer-based ornithological programs in Canada

This list includes only projects that document species abundance and population trends. For a more complete listing of programs that monitor landbirds, you may obtain a copy of the *Canadian Landbird Monitoring Strategy* from: Connie Downes, Migratory Bird Populations Division, National Wildlife Research Centre, Environment Canada, Ottawa K1A 0H3; 819-953-1425 tel; 819-953-6612 fax; Connie.Downes@ec.gc.ca.

Distributional Studies

Bird banding.

Lucie Métras
Bird Banding Office,
National Wildlife Research Centre,
Canadian Wildlife Service,
Ottawa, ON K1A 0H3
tel (819) 997-4213, fax (819) 953-6612
email: Lucie.Metras@ec.gc.ca

Seasonal summaries of bird sightings.

Continent-wide summary published each season in *American Birds*. Participants supply sightings to regional coordinators.

National Audubon Society,
700 Broadway,
New York, NY 10003
tel (212) 979-3000

Studies of Abundance and Population Trends

Breeding Bird Survey (BBS).

Connie Downes,
Migratory Bird Populations Division,
Canadian Wildlife Service,
National Wildlife Research Centre,
Hull, PQ K1A 0H3
tel (819) 953-1425, fax (819) 953-6612
email: Connie.Downes@ec.gc.ca

Canadian Lakes Loon Survey (CLLS).

Russ Weeber
Bird Studies Canada
P.O. Box 160
Port Rowan, ON N0E 1M0
tel (519) 586-3531, fax (519) 586-3532
email: aqpsurvey@bsc-eoc.org

Checklist programs

Alberta Bird Survey Checklist.
Trevor Wiens
Federation of Alberta Naturalists
Box 1472
Edmonton, AB T5J 2K5
tel (780) 453-8629

NWT Bird Survey Checklist
Craig Machtans, CWS
Suite 301, 5204-50th Ave.
Yellowknife, NT X1A 1E2
tel (867) 669-4771, fax (867) 873-8185
email: Craig.Machtans@ec.gc.ca

Étude des Populations d'Oiseaux du Québec (ÉPOQ).
Jacques Larivée
EPOQ
194 Ouellet
Rimouski, PQ G5L 4R5
tel (418) 723-1880

Christmas Bird Counts (CBC).

Contact your local naturalist club for the name of the CBC coordinator in your area, or write:

Geoff LeBaron
National Audubon Society
700 Broadway
New York, NY 10003
tel (212) 979-3000

Forest Bird Monitoring Program (FBMP).

Mike Cadman
Canadian Wildlife Service
Ontario Region
75 Farquhar Street
Guelph, ON N1H 3N4
tel (519) 826-2094, fax (519) 826-2113
email: Mike.Cadman@ec.gc.ca

Hawk counts.

North American Hawk Migration Association
Seth Kellogg (Membership)
377 Loomis Street
Southwick, MA 01077, *or*

William Barnard (Chair)
Norwich University Biology Department
Northfield, VT 05663

Hawkwatches.
(i) Ontario:

Bruce Peninsula
Mark Wiercinski
Box 9
Heathcote, ON N0H 1N0
tel (519) 599-3322

Greater Toronto Raptor Watch (Sept. 1-Dec.)
(Cranberry Marsh / High Park)
John Barker
27 Horizon Crescent,
Scarborough, ON M1T 2G2
tel (416) 291-1598

Hawk Cliff (Sept. 1 - Nov. 30)
Su Ross
483 George Street
Port Stanley, ON N5L 1H1
tel (519) 782-4152

Holiday Beach (Sept. 1 - Nov. 30).
Bob Pettit, President
23393 Meadows Avenue
Flat Rock, MI 48134, USA
tel (313) 379-4558

or Hank Hunt, Canadian Vice-President
tel (519) 948-7015

Niagara Peninsula (March 1 - May 15).
Mike Street
73 Hatton Drive
Ancaster, ON L9G 2H5
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Alberta Hawkwatch
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Manitoba Breeding Bird Atlas.

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Manitoba Naturalists' Society
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Monitoring Avian Productivity and Survivorship (MAPS).

Standardized constant-effort bird-banding to estimate population size and productivity. Banding permit required. Continent-wide, but limited coverage. Contact your local banding group, or:

Lucie Métras
Bird Banding Office
National Wildlife Research Centre
Canadian Wildlife Service
Ottawa, ON K1A 0H3
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Nest Record Schemes

Compilation of records from individual nests (habitat, clutch size, success, etc.).

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Canadian Wildlife Service, Ottawa, Ontario K1A 0H3, tel (819) 953-4390, fax (819) 994-4445,
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